U.S. Department of Transportation
United States Coast Guard

Commandant
United States Coast Guard

2100 Second Street, S.W.
Washington, DC 20593-0001
Staff Symbol: G-SEC-2A
Phone: (202) 267-1892

COMMANDANT INSTRUCTION M16500.24

Subj: SOLAR DESIGN MANUAL

1. PURPOSE. This Manual is a guide for U.S. Coast Guard personnel who design powered aids to navigation power systems.

2. ACTION. Area and district commanders, commanders of maintenance and logistics commands and unit commanding officers shall ensure that the provisions of this Instruction are followed.

3. DIRECTIVES AFFECTED. The solar sizing tables in chapter 10 of COMDTINST M16500.3A Aids to Navigation Manual - Technical are no longer valid and will be removed. New tables are published in this Instruction.

4. DISCUSSION. This Instruction provides District offices, Civil Engineering Units and field units the necessary information to design solar power systems for aids to navigation. This Manual is companion to the solar design program, an Excel spreadsheet intended to run on SWIII terminals. Additionally, solar sizing tables are updated and included in this Instruction to provide field units with quick-reference tables for sizing minor aids.

5. CHANGES. Recommendations for the improvement of this Instruction shall be submitted to Commandant (G-SEC) at jgrasson@comdt.uscg.mil.

6. FORMS/REPORTS. No reports or forms are generated by this Instruction.

Table of Contents

CHAPTER 1 - INTRODUCTION

A. Purpose. The purpose of this publication is to enable a person with little or no familiarity with the fundamentals of solar design to make use of the updated solar design computer program. Additional information is included to assist in the design of solar power systems, including: component selection, wire sizing, suggested sources of supply and solar sizing tables for quick reference power system selection for minor aids.

B. Program Availability. The computer program is available from U.S. Coast Guard Headquarters (Commandant (G-SEC-2)) on an IBM formatted 3-1/2 inch floppy disk. The program is intended to run on the SWIII terminal in Microsoft Excel version 4.0 or later.

C. Special Features. The new computer program differs from the old Solarcalc program in the following ways:

1. The new format of the program in Excel is much more user-friendly, allowing the variables to be entered in any order;

2. The output of the program is immediately displayed. Changes to any of the variables has an immediate affect on the output;

3. The program gives recommended array and battery sizings;

4. Seasonal aids can be easily evaluated by entering the operational interval;

5. Additional data sites are entered to allow more accurate system sizings;

6. Solar sizing tables are included for each data site to provide more accurate sizings for minor aids.

D. Loading the Program. Copy the file SOLARDESIGN(version number).XLS from the floppy onto your hard disk. Remove the floppy and consider it your "Master" copy which should be safeguarded in case the working copy is corrupted or lost.

E. Getting Started. Open a copy of the program. Ideally, the cells B2:M40 should be in view (this may not be possible on laptops; the battery SOC are repeated near the input data). If not, expand the screen by any combination of the following:

1. Under pulldown menu View, select Full Screen;

2. Under pulldown menu View, unselect Status Bar and Formula Bar;

3. Under pulldown menu View, select Toolbars then unselect any checked Toolbars;

4. Under pulldown menu View, select Zoom and adjust the level until the cells are within the limits of the screen.

To simplify data entry, under the pulldown menu Tools, choose Options, Edit, then unselect "Move Selection After Entry".

To prevent users from accidentally deleting or changing cells that perform calculations, all cells are locked with the exception of cells used to enter data. Data cells are shaded yellow or gray, depending on which version of Excel you are using.

CHAPTER 2 - SOLAR DESIGN

A. Introduction. Solar power systems are used on over 90 percent of all lighted aids to navigation. An understanding of the types of power systems and the components used are necessary to design a reliable system.

B. Types. Solar power systems are divided into two categories: self-regulated and regulated. Self-regulated power systems use a solar panel and battery matched to prevent overcharge. Virtually all minor aid power systems are self-regulating. Larger systems (lighthouses, day/night ranges) generally use a charge controller to allow the use of smaller batteries.

C. Equipment. An understanding of the equipment used in a solar power system is necessary to successfully design one. Knowing what components are to be used allows the designer to construct a load profile, system layout and wire sizing for the power system. Chapter 4 details the components used in a typical minor aid, major aid and day/night range. Standard solar lighthouse and range configurations per COMDTINST 16500.8A Automation Technical Guidelines, COMDTINST M16500.3A Aids to Navigation Manual - Technical, and standard aids to navigation drawings provide more detail on categories, hardware and wiring.

D. Loads. Electric power loads of aids to navigation apparatus are often an overlooked variable when designing or troubleshooting a solar power system. Parasitic, daily and nightly loads, if not calculated correctly, can lead to premature failure of the power system. Parasitic loads, however minor, add to the daily load. Each component in the power system and signal equipment must be evaluated as a possible drain on the battery. Chapter 5 details the various loads used on aids to navigation and their power consumption.

E. Wire Sizing. Improperly sized wires in low voltage power systems can have a drastic effect on system performance. The physical separation of the solar array, battery and loads requires ample conductors to limit voltage drop to acceptable levels. Chapter 6 details the calculations necessary to properly size wiring at these installations.

F. Solar Sizing Tables. Chapter 8 contains solar sizing tables for approximately 80 percent of the minor aid power systems. These tables eliminate repetitive calculations and provide field units with quick reference tables for power systems.

G. Assistance. Sample calculations are provided in Appendix I. Design assistance is available from Commandant (G-SEC-2A). The worksheet can be attached or pasted into a Microsoft Exchange e-mail and sent to Commandant (SEC-2A) for evaluation.

CHAPTER 3 - PROGRAM OPERATION

A. Data Entry. The spreadsheet is arranged with data entry from top to bottom. This order should be followed allowing the program to provide accurate system sizing recommendations. Any variable may be changed after all data is entered.

1. Aid Name. Enter the name of the aid in the box provided. The date and time is automatically inserted next to the aid name in order to keep track of the most recent design run.

2. Latitude of Aid. Enter the latitude of the aid in decimal format. Minutes must be converted to decimals by dividing by 60 min/degree; i.e., 4248' = 42.80 . Minor aids may use the latitude of the reference site.

3. Panel Tilt. The panel tilt is the angle of the solar panel(s) with respect to horizontal. Generally, panel tilt for minor aids with nighttime loads is:

Alaska	75 degrees
Continental U.S.	60 degrees
GANTSEC & Hawaii	30 degrees
Buoys (Horizontal Mount)	0 degrees
Tripod Buoy Mount	60 degrees
Dual Panel Mount	15 degrees

Panel tilt for some Northern Continental U.S. sites can benefit from a steeper angle to capture more power in the winter. Day/night ranges generally benefit from a shallower tilt angle (45 degrees) as the maximum load occurs during the summer. Exposed location buoys and buoys with large signal packages should use the solar vertical design program available from Commandant (G-SEC-2A).

4. Ref Site #. Enter the data site number closest to the aid being evaluated. If the aid is between two sites, perform two design runs using each site and pick the solar sizing with the largest power system. Chapter 7 contains 92 data sites for the U.S., GANTSEC and Guam.

5. Use Average Rad? Solar power systems must be designed using Design Radiation. Design radiation represents low radiation values that can be expected to occur once every 10-15 years. These are not the lowest radiation values possible, but values that we feel comfortable designing around. **Leave this box blank to use design radiation.** Use average radiation to see how a system will perform during an "average" year, and to determine how long it will take a system to recover from a low state of charge caused by personnel error or component failure.

6. Battery Type. Enter the battery type used by your ANTs/Tenders, or selected for a specific project. Delco-2000, Exide HC-31, Yuasa-Exide EI, EJ and FHGS batteries are **wet** batteries. The Sunlyte 12-5000 is an **abs**orbed battery and the Deka 8GH30, Dynasty GC12V100B and Sonnenschein Dryfit A600 are **gel**led batteries.

7. Autonomy. Autonomy is the amount of time the aid will perform with little or no sun and is used to determine the minimum battery size. The default is 10 days; 10-14 days are typical, depending on local weather conditions (fog, rain, overcast periods).

8. Interval Installed. Refers to when the program starts calculating the results of the design run. For example, if a temporary aid is installed in the beginning of June and will operate for 2 months, enter interval 11 and note the results during intervals 11 through 14. Otherwise, enter interval **18** as almost all systems are fully charged during this period. Be sure the maximum state of charge returns to 100 percent at interval 17 or the aid may fail.

9. SofC at Install. Refers to the state of charge of the battery at installation. Generally, the battery is fully charged when installed (100(%)). This entry allows the user evaluate an aid with a failed battery to determine how long the array will take to charge it back to 100 percent.

10. Load. Optional field used to describe the load entered, i.e., RL14, 35w, Iso6.

11. Amps? The load current in amps. Refer to chapter 5 for current consumption figures. NOTE: when lamps are flashed, the average current (accounts for cold current surge) must be entered; i.e., **0.916** for a 0.77a lamp with a **Q**uick flash rhythm.

12. Duty Cycle. Enter the duty cycle of the load as found in chapter 5. The default duty cycle is 100 percent.

13. D, N or DN. Enter when the load is on. Daylight controlled loads operate only at night so enter a **N**. Daytime loads, typically daytime range lights, Range Power Boxes and Range Switch Boxes operate only during the **D**ay. Loads on 24 hours a day like rotation motors, sound signals and control equipment are entered as **DN**.

14. # Hours Day/Night Loads Operate. If the loads are on a fixed amount of time (using a timer) or as an estimate for a fog detector controlled sound signal (8-12 hours/day), enter the number of hours the load operates. Otherwise leave this box blank. Note: **DN** must be entered in the adjacent block if a value is entered.

15. Seasonal Aids ON/OFF. If the load is seasonal, i.e., a sound signal that is turned off during the winter season, enter the interval that the device operates. This is useful in northern latitudes when unnecessary winter loads can be secured thereby saving power and reducing the power system size.

16. Number of flashers. Enter the maximum number of CG-181 or CG-481 flashers that are operating at the same time, i.e., day/night ranges typically have one optic powered during the day and one on at night which count as one flasher.

NOTE: When overwriting or clearing an entry, use the backspace key to delete numbers and characters. Do not use the spacebar to clear entries, as the program will not interrupt them correctly.

17. Array Size. If evaluating an existing aid, enter the size of the array in watts, or if designing a new system, enter the *suggested array size*. For minor aids, enter the advertised solar panel wattage, i.e., 10, 20 or 35 watts. Aids using multiple panels should use the actual wattage produced by the solar panels. 10 and 20 watt panels are entered as 10 and 20 watts. 35 watt panels manufactured by Siemens Solar Industries are entered as multiples of 40 watts as it is impractical for them to trim solar cells to specific power levels. Additionally, aids using more than 100 watts should use multiples of 35 (40) watt solar panels; don't try to fine tune the array with 10 and 20 watt panels. Commandant (G-SEC-2) will publish the current power production of 35 watt solar panels when major changes occur. Aids using the molded acrylic pyramid require a 35% reduction in power output (multiply panel wattage by 0.65)
Do not use this program to evaluate other than CG standard panels and Siemens M65 panels.

18. Battery Size. If evaluating an existing aid, enter the battery size in amp-hours, or if designing a new system, enter the *suggested battery size*. Note that there are two choices. Minor aid systems are usually self-regulated meaning that there is no charge regulator. Instead, the battery is large enough to absorb any overcharge that the CG standard solar panel produces. Wet batteries are more tolerant of overcharge, therefore the suggested battery size using wet battery types is smaller than gelled or absorbed cells. The battery type chosen is dependent on Unit or Designer preference. Systems using a charge controller or Range Power Box (RPB) can use the suggested battery size for regulated systems. Regulated power systems should be used when the load is uncertain (fog detector) or to reduce the size, weight and cost of the battery system. Minor aid systems use multiples of 100 amp-hours; 300 amp-hours is the limit on shore aids, 500 amp-hours on buoys. Shore aids exceeding 300 amp-hours should use the Yuasa-Exide EJ/FHGS, the Absolyte II or Sonnenschein A600 Dryfit cells. Battery sizes in northern latitudes may be increased beyond the suggested size in lieu of increasing the array size to meet the minimum SOC requirements.

Be sure to press ENTER after the last entry in order for the program to calculate the results.

19. Comments. Use this block to add any specific comments about the design that you want filed with the printout.

B. Program Output. The program output is printed on the right side of the spreadsheet. Any of the input variables can be changed at this time to fine tune the output, if necessary.

1. Interval Number. Refers to the half-month interval being evaluated.

2. Dates. Refers to the dates during the interval when the results are calculated.

3. Minimum SOC(%). The battery's minimum State of Charge (SOC) during the specific interval.

4. Maximum SOC(%). The battery's maximum state of charge during the specific interval. The maximum SOC should be 100 percent during a majority of the year to ensure that the battery fully recharges.

5. Minimum SofC: The lowest minimum state of charge for intervals 1-24. As a general rule, a minimum SOC of 70 percent (65 percent for minor aids) should not be exceeded. 70 percent is not a goal; anything between 70 percent and 95 percent is acceptable. The minimum SOC can be raised by increasing the array size. Northern latitudes may also benefit from increasing the battery size. NOTE: In self regulating systems, increasing the array size may require a larger battery.

6. Maximum Daily Load. The maximum daily load in ampere-hours/day. For nighttime loads, this occurs on December 21 and for daytime loads on June 21.

7. C/50 or C/100: The maximum allowable charge rate in amperes for self regulating systems using either wet (C/50) or absorbed/gelled batteries (C/100). The program uses this number for sizing batteries in self regulating systems.

8. Max Charge Rate. The maximum charge current produced by the solar array. This value is useful when sizing wiring in the power system and when troubleshooting as it can be compared to the measured charge current through the charge controller under bright sun conditions.

C. Printing. The entire input/output portion of the spreadsheet will fit on an 8-1/2"x11 sheet if printed as landscape. The print area should already be set, otherwise click on cell B2, hold the Shift key down and click on cell M40. This will highlight the area to be printed. Under pulldown menu File, select Print Area, Set Print Area, then Print.

CHAPTER 4 - EQUIPMENT

A. Minor Aids. A typical solar powered minor aid to navigation (figure 1) consists of the standard lighting hardware (lantern, lampchanger, flasher, lamps), a 10, 20 or 35-watt solar panel and single or multiple 12-volt, 100-ampere-hour (ah) photovoltaic batteries. Most minor aid sizings are already calculated and listed in the Solar Sizing Tables in chapter 8. Some ranges and minor aids using fixed burning lamps in range lights or rotating beacons require larger (> 300-ah) battery banks and will typically use components listed in the next sections. COMDTINST M16500.3A provides detailed information on these components.

Figure 1.

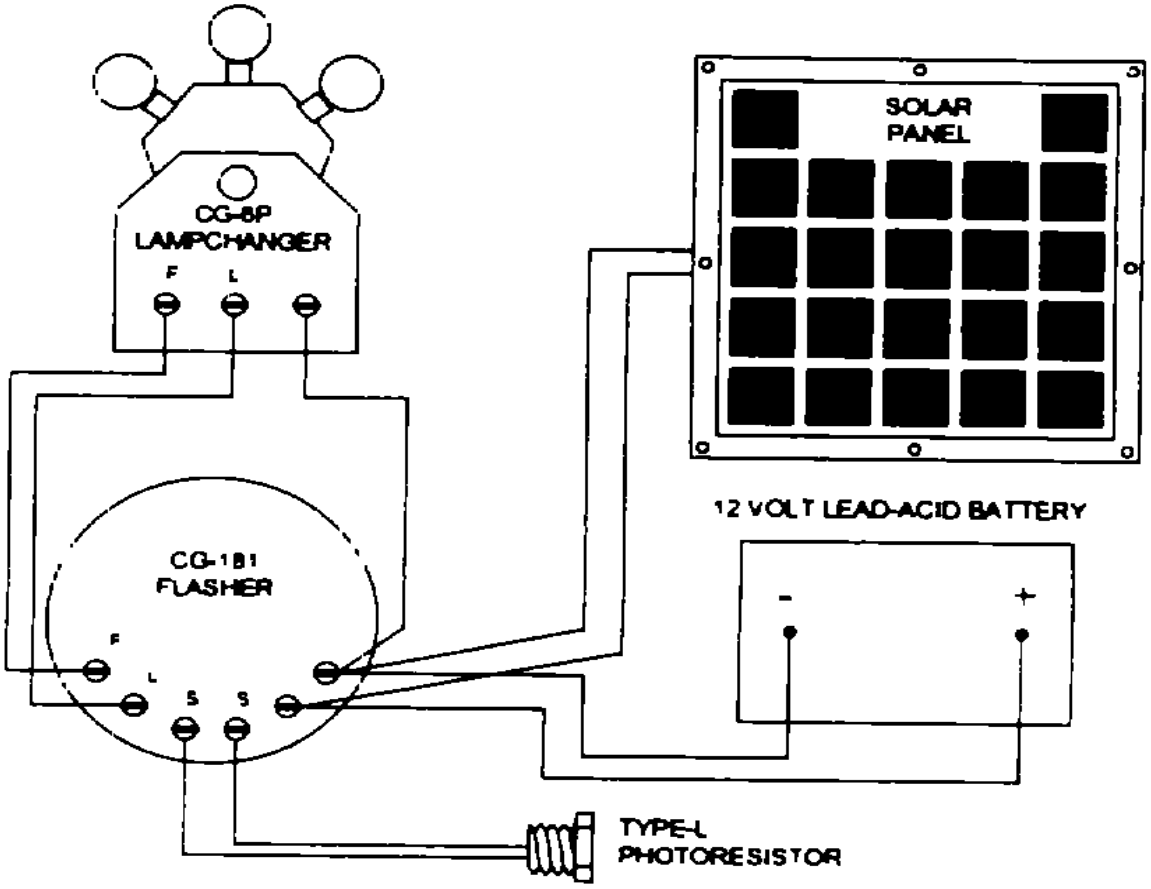


Figure 1.

B. Major Aids. A generic solar powered lighthouse (figure 2) will have a main array and battery system, an emergency battery with a small trickle charge solar panel, a main light, main sound, and emergency light and sound. Inputs from solar panels are gathered into Local Terminal Boxes (LTBs) and a PV Combiner, and a charge controller prevents overcharge of the battery. A Solar Distribution Box (SDB) provides a centralized location to combine solar power inputs and distribute power to the loads. COMDTINST M16500.8A and standard AtoN drawings 140400 series provides detailed information on these systems.

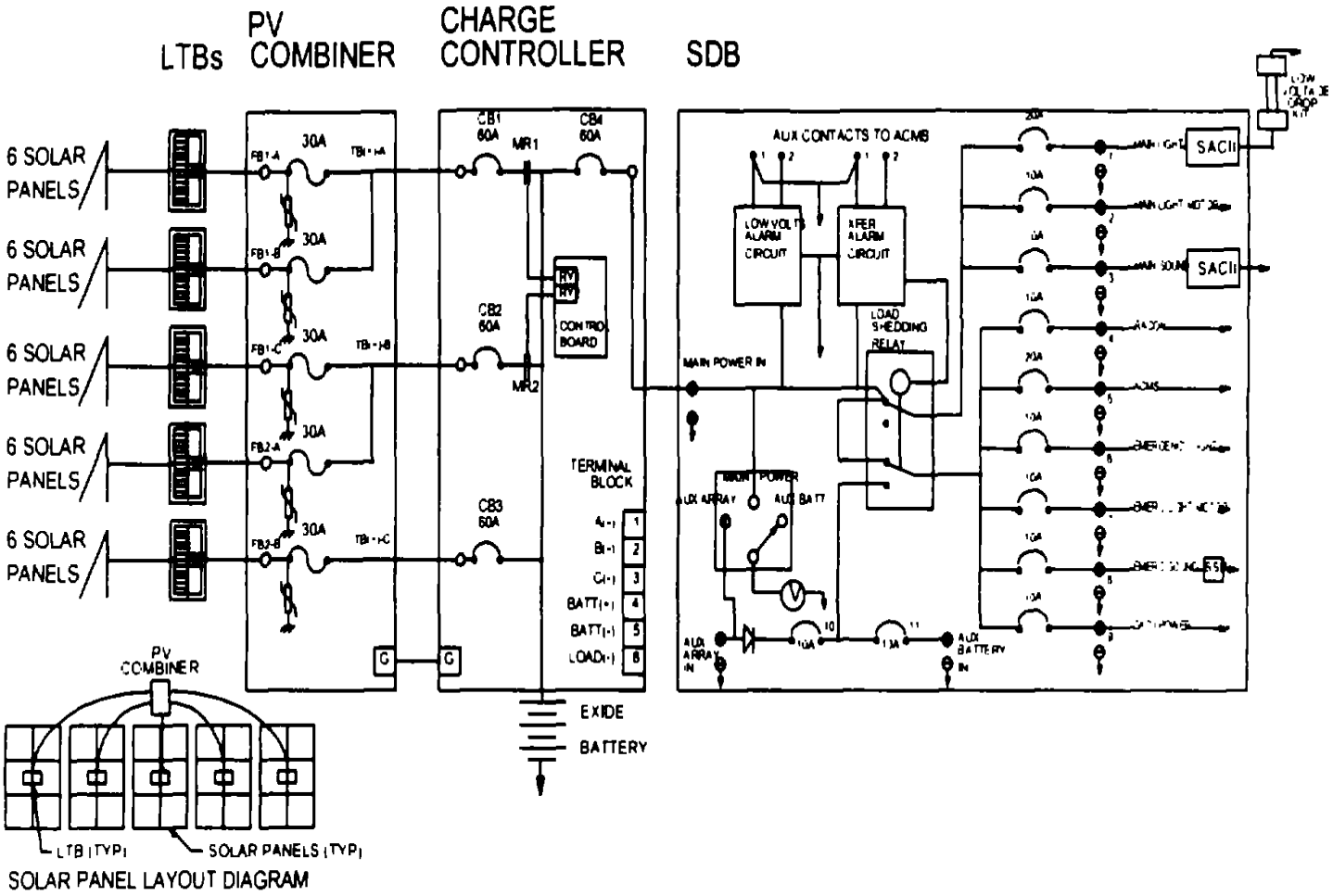


Figure 2.

Figure 2.

C. Day/Night Ranges. Day/night ranges typically require large solar arrays due to the continuous loads associated with these aids. Many sites can benefit from shallower (45 degrees versus 60 degrees) tilt angle as the greatest loads occur during the summer months. Solar panels are gathered into a Local Terminal Box (LTB) and fed into a Range Power Box (RPB). The RPB is a commercially available photovoltiac charge controller manufactured by Specialty Concepts, Inc., and provides overcharge protection, low voltage disconnect (to protect against deep discharge) and a load center. The power is then routed to the Range Switch Box-DC (RSB-DC) which controls the day/night range lights. COMDTINST M16500.8A and standard AtoN drawings 140500 series provides detailed information on these systems.

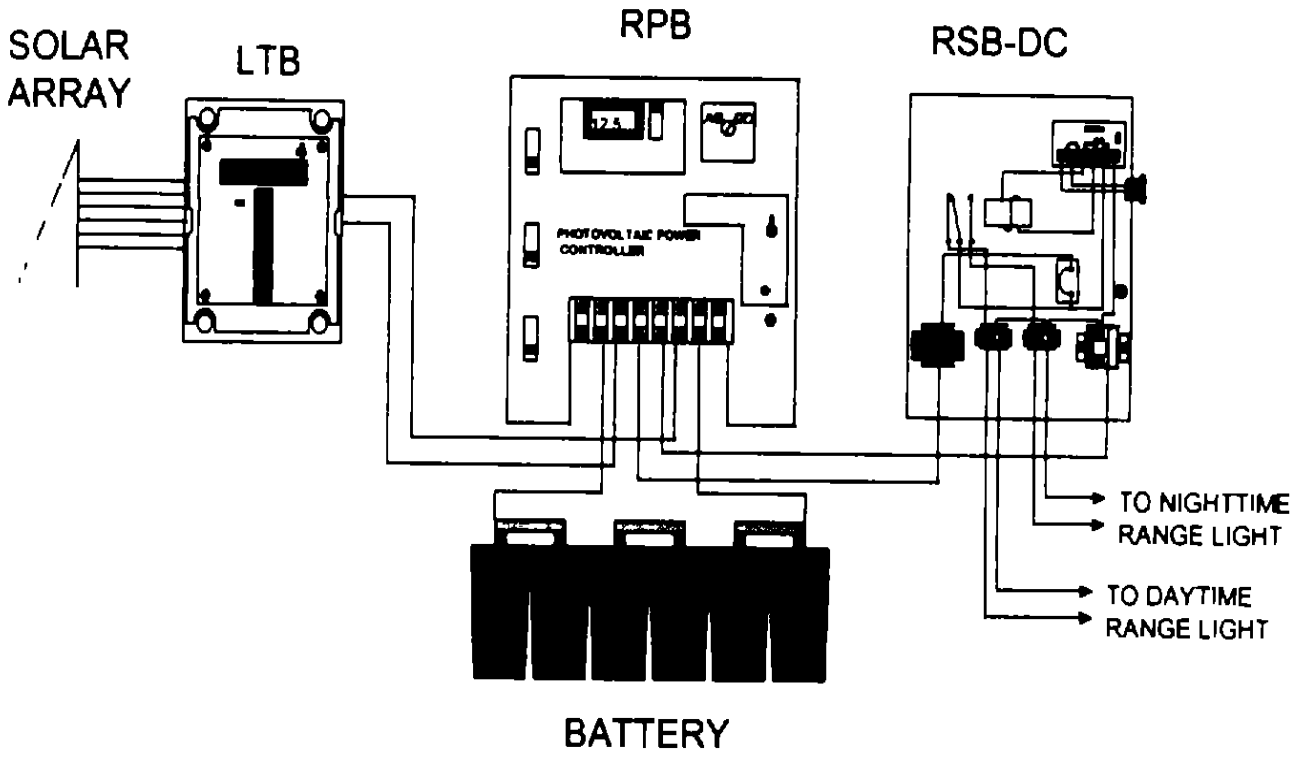


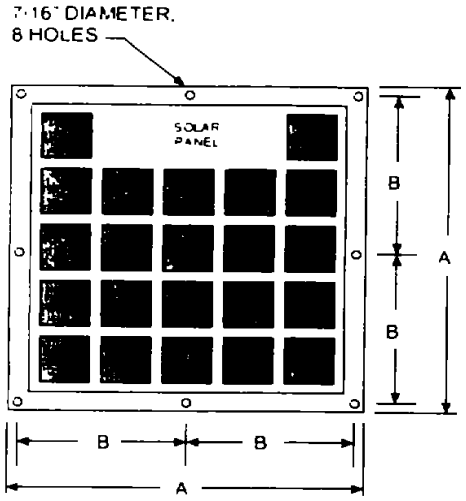
Figure 3

Figure 3

D. Solar Panels. CG standard solar panels are procured from vendors listed on a Qualified Products List (QPL) by ELC Baltimore. Power ratings are 10, 20 and 35-watts. The current vendors are:

Solarex Corporation
Siemens Solar Industries
Kyocera America, Inc.

CG standard panel sizes and mounting details are shown in figure 4.



	A	B
10 WATT	16"	7 1/2"
20 WATT	22"	10 1/2"
35 WATT	28"	13 1/2"

Figure 4.

Figure 4.

U.S. Coast Guard solar panels use between 29 and 33 crystalline or semi-crystalline silicone cells (32 cells typical) with a maximum power point (point in panel performance curve that yields maximum voltage and current) of 13.8 volts at 25 degrees C (cell temperature). This power point voltage charges lead-acid batteries at most solar installations without the use of a regulator. Commercially available panels, such as the Siemens M-55, a 12 volt, 50 watt panel, have a maximum power point of 17.0 volts, must use a regulator, and can not be evaluated with this design program. The program can be modified to allow sizings with non-standard panels; consult with Commandant (G-SEC-2A) for assistance.

The Siemens M65 solar panel is similar in power output to the CG standard 35 watt module, but not as robust and is not suitable where wave action reaches the array. Power output is 43 watts as the frame is more densely packed than our standard module making it suitable for high density arrays. The Siemens Standard Ground Mount (SGM) may be used to mount these panels. Appendix IV contains data sheets on these components. This program may be used to design arrays using M65 panels.

The transparent clear acrylic pyramids used as bird deterrents on buoys

prevent the solar panel from producing full power. A correction factor must be applied to horizontal buoy mounted solar panels equipped with clear acrylic pyramids. Tests at the CG R&DC indicate a 35% reduction in power output for these installations. Bird springs and similar deterrents have a negligible effect on power output and no correction factor applies.

Installations using single or multiple panels mounted at the same tilt angle and oriented in the desired direction (South for installations in the Northern Hemisphere) can use this program to predict performance. When odd mounting schemes are used, i.e., the dual (15 degree tilt) or (60 degree tilt) tripod mount on lighted buoys, an equivalent panel arrangement must be specified to predict results: The tripod mount can be approximated by using 1.2 times the single panel output, mounted 60 degrees facing South. The dual panel mount can be approximated by using 1.8 times the single panel output, mounted 15 degrees facing South

Minor aid buoys installed in Northern latitudes and all buoys with large signal suites may benefit from either two or four vertical panels installed on the superstructure in lieu of a single horizontal panel. These sites can be evaluated using the Solar Vertical design program, available from Commandant (G-SEC-2). Appendix II contains an addendum detailing operation of the Solar Vertical program

E. Batteries. Secondary (rechargeable) batteries for solar applications are generally procured on the open market from vendors providing products that meet specific salient features. Occasionally, a General Services Administration schedule will be available for certain battery types. Appendix III contains suggested sources or supply of batteries for major and minor aids to navigation.

Most batteries for commercial use are rated at the 8 or 20 hour discharge rate. Capacities of batteries used in photovoltaic systems are generally specified at the 100-hour discharge rate. As an example, a minor aid battery (12 volt, 100 amp-hour) must be able to power a 1 ampere load for 100 hours.

Batteries for minor solar powered applications (300-ah or less) are lead-calcium construction. Lead-calcium batteries are available with various types of electrolyte: liquid, absorbed (liquid saturated in a sponge or mat), and gelled. The latter two types are spill-proof. The scheduled replacement for minor aid batteries is 6 years.

Batteries for major (greater than 300-ah) solar powered applications are generally purchased as 2 volt cells. Six cells are needed for a 12 volt system. Wet batteries, like the Exide EI (to be replaced by the EJ), EJ and FHGS, are the most forgiving and reliable, however they must be installed on very stable platforms (monopoles are unacceptable). Cases are clear to allow plate and sediment inspection and specific gravity can be measured. They do require semiannual watering and the cases are quite fragile when transporting to the aid.

Alternatives are gelled electrolyte imported from Germany (Sonnenschein) and absorbed electrolyte (GNB Absolyte II). The latter can be stacked vertically, if floor loading will allow. These batteries are limited to voltage checks as the electrolyte is immobile and cases are opaque. Batteries for these applications will typically last 10-20 years. The choice between liquid, gelled or absorbed electrolyte depends on personal preference, the ability to transport cells, installation area, and whether visual status of the internal condition of the battery is desired. Appendix IV contains data sheets on these batteries.

Batteries being charged will break down water in the electrolyte by electrolysis into hydrogen and oxygen. The degree of charging and overcharging will determine the amount of water lost. In wet type batteries (Exide), the water level can be monitored and a schedule established to rewater. In absorbed and gelled batteries, the same gassing process occurs, but cells usually have recombination caps which convert the gases generated back into water. However, these batteries have a safety valve that will vent when gassing is severe. Prolonged gassing of these cells will dry out the battery, which is undetectable and will lead to premature failure. This is why charge rates for these batteries are more conservative.

F. Charge Controllers. A charge controller is a device that prevents the battery from overcharging after the battery is fully charged. The charge controller also provides overcurrent protection for the array string(s) and load(s). Solar power lighthouses and most day/night ranges require a charge controller. Most minor aids are self regulating and do not use a controller.

There are two type of controllers presently used: The Range Power Box (RPB) which is a commercially available charge controller from Specialty Concepts, Inc., designated the PPC/50-12-4X can handle up to 50 amps charge current. This is used exclusively on ranges requiring regulation. The Process Automation Co., model 1579 is used at solar power lighthouses and ranges with a capacity of up to 180 amps charge current and is capable of multiple panel string input. Both offer field optional low voltage disconnect which removes the load if the battery state of charge falls to a low level. The controllers have temperature compensation probes which must be attached to the battery to ensure proper operation. The probe has 25 feet of wire attached, necessitating close placement of the controller to the battery. A data sheet for the PPC is included in appendix IV. COMDINST M16500.3A will be updated to include data sheets on both controllers. Charge termination setpoints in both controllers are selectable. The setpoint for wet batteries is 14.8-15.0 volts and for absorbed or gelled batteries is 14.7-14.8 volts. Setpoints may be raised if batteries are not fully charged during periods when the battery is expect to be fully charged.

CHAPTER 5 - LOADS

Specific loads must be entered into the program in order to create a profile of daily power consumption. The following is a consolidated list of loads often found on minor and major solar powered aids:

A. Lamps. Lamps that are flashed consume more than their rated current because of the cold current surge associated with tungsten filaments. The following table lists average lamp currents for typical flash rhythms (some areas are blank as either the lamp/rhythm combination is not allowed or not used). Average current for non-standard rhythms is based on the shortest ON time of the rhythm. Therefore a nonstandard rhythm with a 0.3 second flash will have the same average current as a **Q**uick flash, however the duty cycle for the nonstandard rhythm will have to be calculated. The duty cycle is:

$$\text{Duty Cycle} = \frac{\text{Time ON}}{(\text{Time ON} + \text{Time OFF})} \times 100$$

Average Lamp Current in Amperes for Rated Lamp Sizes

Rhythm	**Duty Cycle**	**0.25a**	**0.55a**	**0.77a**	**1.0a**	**1.15a**	**1.9a**	**2.03a**	**3.0a**	**3.05a**	**50w**	**75w**	**100w**	**110w**
Fixed	100	.250	.550	.770	1.00	1.15	1.90	2.03	3.00	3.05	4.17	6.25	8.33	9.17
Oc 4	75	.252	.559	.785	1.02	1.18	1.97	2.10	3.12	3.17	4.35	6.54	8.75	9.63
Iso 6	50	.252	.559	.785	1.02	1.18	1.97	2.10	3.12	3.17	4.35	6.54	8.75	9.63
Iso 2	50	.258	.578	.816	1.08	1.24	2.11	2.23	3.37	3.42	4.73	7.20	9.75	10.73
Fl(2)6	33	.258	.578	.816	1.08	1.24	2.11	2.23	3.37	3.42	4.73	7.20	9.75	10.73
Q	30	.278	.639	.916	1.24	1.42	2.55	2.76						
Mo(A)	30	.262	.592	.844		1.29		2.38		3.70				
IQ	18	.278	.639	.916		1.42		2.76						
Fl2(5)	16	.271	.621	.894		1.38		2.62		4.15				
Fl(2+1)6	15	.278	.639	.916		1.42		2.76						
Fl 2.5(.3)	12	.278	.639	.916		1.42		2.76						
FL2.5(1)	40	.258	.578	.816	1.08	1.24	2.11	2.23	3.37	3.42	4.73	7.20	9.75	10.73
Fl 4(.4)	10	.271	.621	.894		1.38		2.62		4.15				
FL4(1)	25	.258	.578	.816	1.08	1.24	2.11	2.23	3.37	3.42	4.73	7.20	9.75	10.73
Fl 6(.6)	10	.266	.596	.859		1.31		2.45		3.81				

B. VRB-25 Rotating Beacon. The VRB-25 is the standard 12 volt rotating beacon. It replaces the Amerace ESNA 190mm beacon and API FA-251-DC. The power consumption of the lamp is entered as a **N**ighttime only load at its rated current and **100**% duty cycle as the flash rhythm is **Fixed**. The power consumption of the rotation motor must be entered into the program as a separate load. The motor typically operates 24 hours a

day in order to prevent the sun from focusing on the lampchanger. Power consumption is **0.10** amps, **100**% duty cycle, **D**ay/**N**ight load.

C. API Flashtube. The power consumed by the API 12-volt flashtube may be calculated as follows:

The power consumption must be calculated for each flick of the flashtube:
XFB-001 = 0.39 amp-secs, flash rate of 1 flash per 0.40 seconds
XFB-005 = 1.34 amp-secs, flash rate of 1 flash per 0.55 seconds
XFB-010 = 2.28 amp-secs, flash rate of 1 flash per 0.95 seconds
XFB-015 = 2.87 amp-secs, flash rate of 1 flash per 1.20 seconds

Where the flash rhythm must be equal to or longer than the flash rate listed above.

Next, the power consumption for the specific rhythm must be calculated. For a 5 joule flashtube (XFB-005) with one flash every 2.5 seconds equals:

Flash rate is within limitations (1 flash every 2.5 seconds; 2.5s 0.55s):
1.34 amp-secs / 2.5 secs = 0.536 amps

The idle current of the flashtube must be added to this. It is 8 milliamps for all models:

0.536 amps + 0.008 amps = 0.544 amps.
Enter this as a **N**ightly load if daylight controlled with a **100**% duty cycle.
Note: this calculation is different from what was previously published and existing aids using this device should be re-evaluated.

D. Multiarray Controller (MAC), Solar Distribution Box (SDB) & Solar Aid Controller SAC II). The MAC and SDB consume and average of **0.025** amps, continuous. The SAC II consumes an average of **0.0025** amps, continuous. These loads are day/night loads. A typical lighthouse with a SDB and 2 SACIIs will consume **0.030** amps, **100**% duty cycle, **D**ay/**N**ight load. The SDB will accept up to 1/0 AWG for main battery input, 6 AWG for emergency panel and battery input, and lugs sized for a number 10 stud for all loads.

E. Charge Controller. The charge controller used in lighthouse and large range solarizations manufactured by Specialty Concepts and Process Automation Company consumes **0.010** amps, **100**% duty cycle, **D**ay/**N**ight load. The controller does draw considerably more power when the mercury relays are energized, however this occurs when excess power is generated by the array in the daytime and the load does not have to be accounted for. It will accept up to 1/0 AWG wire for all inputs/outputs.

F. Range Power Box (RPB). The RPB is a commercially available charge controller manufactured by Specialty Concepts, Inc. Its is designated the PPC/50-12-4X and consumes **0.190** amps continuous, **100**% duty cycle, during the **D**aytime. It will accept up to 6 AWG wire for all inputs/outputs.

G. Range Switch Box-DC (RSB-DC). The RSB-DC is used on DC powered ranges to switch between daytime and nighttime lights. The RSB-DC consumes **0.170** amps continuous **100**% duty cycle, during the **D**aytime. The maximum wire sizes that can be used is 1/0 AWG for input power and 10 AWG for output to each range light.

H. Racon. The maximum power consumption estimates are as follows: 0.55 amps, on a 30% maximum duty cycle, 24 hours a day while transmitting, and 0.067 amps, 70% minimum, 24 hours and day while idle or listening. These estimates include continuous interrogation. The load may be simplified as **0.212** amps continuous **100**% duty cycle, **D**ay/**N**ight load.

I. Sound Signals. Power consumption for sound signals is entered as a **D**ay/**N**ight load during blast only; consumption during eclipse is negligible.

Model	Range (nmi)	Current (amps)
SA-850	1/4-1/2	1.25
SA-850/02	1.0	3.25
SA-850/4A	2.0	7.00
FA-232	1/4-1/2	1.80
FA-232/02	1.0	3.60
FA-232/04	2.0	9.00

Duty cycles for common rhythms are:

Rhythm	Time (On/Off)	Duty Cycle
1 blast every 10 sec	1bl/9si	10%
1 blast every 30 sec	3bl/27si	10%
2 blasts every 60 sec	3bl/3si/3bl/51si	10%
1 blast every 15 sec	2bl/13si	13.3%
2 blasts every 30 sec	2bl/2si/2bl/24si	13.3%
2 blasts every 20 sec	2bl/2si/2bl/14si	20%

For uncommon rhythms, the duty cycle may be calculated as follows:

$$\text{Duty Cycle} = \frac{\text{Time ON during blast (seconds)}}{\text{Time ON during blast + Time OFF during eclipse}} \times 100$$

J. Fog Detector. There are two types of fog detectors currently in use: the VM-100 and Videograph B. The latter is being phased out and will eventually be replaced by the VM-100. The VM-100 is more energy efficient than the Videograph B and solarization efforts should schedule replacement of the Videograph as part of the project. The operating currents of the Videograph B and VM-100 are 0.67 and 0.80 amperes, respectively. This is entered into the program as a continuous, 100% duty cycle, Day/Night load.

All fog detectors have heaters in the projector and receiver windows to eliminate condensation in cold weather. The heaters in the Videograph B consume 2.0 amperes and turn on when the ambient outside temperature is below 50 degrees F. The heaters in the VM-100 consume 1.0 ampere and turn on when the ambient outside temperature is below 25 degrees F. Since temperature is variable, the amount of time the heaters are activated must be estimated. Enough reserve capacity is necessary to account for extremely harsh winters, however cold days are usually clear and may be considered "average insolation days". As a check, increase the duty cycle of the heater load and see if the battery SOC is acceptable using "average insolation" rather than "design insolation". Listed below are selected data sites, and the suggested duty cycle for the VM-100 heater load:

	VM-100 HEATER LOAD		
Data Site#	Data Site Name	Suggested Duty Cycle	Suggested Internal
1	Portland, ME	100%	23 - 6
2	Boston, MA	75%	23 - 4
3	Providence, RI	75%	23 - 6
4	Bridgeport, CT	75%	23 - 4
5	New York, NY	50%	23 - 4
8	Newark, NJ	50%	23 - 4
12	Baltimore, MD	50%	23 - 4
49	Rochester, NY	100%	23 - 6
50	Buffalo, NY	100%	23 - 6
51	Erie, PA	100%	23 - 6
52	Cleveland, OH	100%	23 - 6
53	Toledo, OH	100%	23 - 6
54	Detroit, MI	100%	23 - 6
55	Alpena, MI	100%	21 - 6
56	Traverse City, MI	100%	23 - 6
57	Muskegon, MI	100%	23 - 6
58	Chicago, IL	100%	23 - 6
59	Milwaukee, WI	100%	23 - 6
60	Green Bay, WI	100%	21 - 6
61	Sault Ste. Marie, MI	100%	21 - 6
62	Houghton, MI	100%	21 - 6
63	Duluth, MN	100%	21 - 6
76	Portland, OR	0%	N/A
78	Quillayute, WA	0%	N/A

79	Seattle, WA	0%	N/A

K. Low Energy Aid Control Monitor System (LEACMS). The LEACMS is a low power version of the ACMS and can be used at solar powered lighthouses to monitor the status of the aid, including low battery alarm and main battery transfer. The LEACMS may be outfitted with an EF Johnson radio or cellular phone link to the master control unit. The power consumption of the LEACMS with the EF Johnson radio is **0.50** amps continuous, **100**% duty cycle, **D**ay/**N**ight load, and with the cellular link is **0.75** amps continuous, **100**% duty cycle, **D**ay/**N**ight load.

CHAPTER 6 - WIRING SIZING

A. General. In conventional electrical systems (120-240 VAC), wire is sized according to its safe amperage carrying capacity know as "ampacity". A voltage drop of 2-3 volts in these systems is acceptable. Since voltage drop is based on wire size and current, not voltage, if these practices are carried over to low voltage systems, the resultant voltage drop would cause inadequate charging of the battery and low voltage to the aids to navigation.

B. Acceptable Voltage Drops. The acceptable voltage drop for 12 volt solar power aids to navigation is 0.75 volts in the charging system and 0.35 volts for the load(s). The "charging system" is considered the wire run from the solar panels to the battery, and the "load(s)" is considered the wire run from the battery to the device (CG-181, FA-232, etc.). **These voltage drops are maximums and efforts to reduce these values is encouraged.** The voltage drop for minor aids remains at 0.10 volts for the load.

C. Wire Sizes and Typical Voltage Drops. The following are common wire sizes and their calculated voltage drop for a 1 amp current at 1000 feet:

Wire Size	**K***
12 AWG	3.960 volts
10 AWG	2.480 volts
8 AWG	1.556 volts
6 AWG	0.982 volts
4 AWG	0.616 volts
2 AWG	0.388 volts
1/0 AWG	0.244 volts
2/0 AWG	0.193 volts
3/0 AWG	0.153 volts
4/0 AWG	0.122 volts

*These K values are based on National Electric Code (NEC) recommendations for uncoated, stranded copper conductors. These values are conservative. Resistance values from the cable supplier may be used to calculate new K values. To calculate **K**:

K = Wire Resistance (ohms) per 1000 feet x 2

Therefore, the voltage drop for a given wire run is:

$$\textbf{V}\text{oltage }\textbf{D}\text{rop (V1324 Drop \& TA \&)} = \frac{K \times A \times D}{1000}$$

Where: A is the current in amperes
D is the one way distance in feet

D. Operating Current. The operating current must be found before the wire size can be calculated. For solar arrays, the current is equal to the rated wattage divided by the peak power point voltage. For USCG standard panels, the power point voltage is 13.8 volts. For loads, the current consumed by each operating device must be summed for each segment of wire.

E. Example - Day/Night Range. Figure 5 is a typical day/night range installation. This aid has six 40 watt solar panels (battery size is unimportant), a daytime range light with 12 volt, 35 watt lamps and a nighttime light with 0.55 amp lamps. The array is 25 feet from the RPB and the range lights are 100 feet from the RPB. The RPB is 6 feet from the battery.

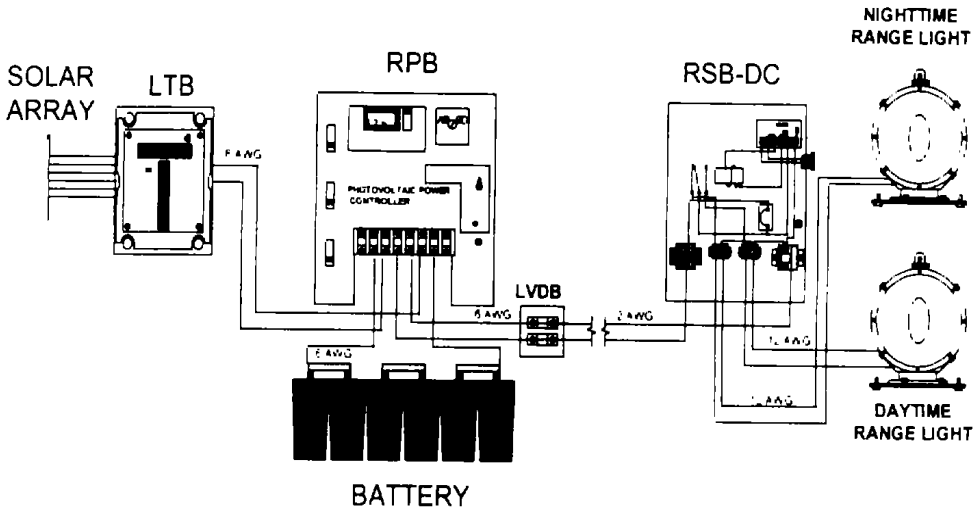


Figure 5

Figure 5

The 6 solar panels are terminated in one Local Terminal Box (LTB), therefore the current produced by the array is:

$$array = \frac{6 \times 40 \text{ watts}}{13.8 \text{ volts}} = 17.4 \text{ amps}$$

The run from the LTB to the battery, through the Range Power Box (RPB) is sized using 6 AWG wire:

$$Drop\ 1 = \frac{0.982 \text{ volts} \times 17.4 \text{ amps} \times 25 \text{ feet}}{1000} = 0.43 \text{ volts} \quad \text{(LTB to RPB)}$$

$$Drop\ 2 = \frac{0.982 \text{ volts} \times 17.4 \text{ amps}^{*} \times 6 \text{ feet}}{1000} = 0.10 \text{ volts} \quad \text{(RPB to Battery)}$$

*The daytime charge current through this leg is actually reduced by the daytime load

CHAPTER 8 - SOLAR SIZING TABLES

A. Discussion. Solar sizing tables are provided as a quick reference for buoys and fixed structures using simple rhythms and power systems. The tables do not cover installations with multiple loads (lantern & sound signal) nor multiple solar panel arrays. Sizings are limited to 35 watts and 300 amp-hours for structures, and 35 watt and 500 amp-hours for buoys. Aids with power requirements that exceed these limits should perform a design run to determine optimum system sizings; buoy installations in excess of this limit may benefit from using dual or quadruple vertically mounted solar panels.

The tables are revised to reflect the new data provided by NREL. In many cases, the designs are more conservative compared to the old tables and increases in panel and battery size are common. To alleviate this problem, tables are provided for all 92 data sites as the old sizing tables picked the worst one or two data sites in the district and based all calculations on these sites.

To use the tables, find the data site nearest to the aid and select the appropriate row containing the flasher rhythm and aid type (**B**-Buoy, **S**-Structure). Next, find the column containing the lamp required for the aid. The intersection of the row and column lists the required power system. A 10/100 refers to a 10 watt solar panel and one minor aid solar battery (100 amp-hours nominal capacity). If the aid is between two data sites, look up the power system combination for both sites and use the larger of the panel/battery combinations. If the intersection is blank or marked "N/A", either the combination is normally not used or the system sizing exceeds the limitations detailed above. Calculate the system sizing using the solar design program or the solar vertical program (dual and quad mounts on buoys).

Also, note that the sizing tables are intended for wet or liquid electrolyte batteries (Delco, Exide). Use of absorbed (Sunlyte) or gelled (Sonnenschein, Johnson Controls, Deka) batteries may require more units to ensure overcharge protection. As a general rule, a minimum of one, two and three batteries of these types are needed when using 10, 20 and 35 watt panels, respectively, or the combination cited in the table, whichever is larger.

SOLAR SIZING TABLE - 1 - Portland, ME **Lat 43.65N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	20/200	N/A	35/400	
FL6(.6)	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/300
FL2.5(.3)	B	10/100	20/100	20/100	N/A	35/200	N/A		N/A
	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	35/200	N/A	35/200	N/A		
FL(2)5	S	10/100	10/100	20/100	N/A	20/200	N/A	35/300	
Q, FL2(6) or	B	20/100	35/200	35/400	N/A		N/A		
Mo(A)	S	10/100	20/100	35/200	35/200	35/300			
FL4(1)	S	10/100	20/100	20/100	35/200	35/200			
FL2.5(1)	S	10/100	20/200	35/200	35/300				
Iso6 or Iso2	S	20/100	35/200	35/200					
Oc4	S	20/100	35/300						
Fix	S	20/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 2 - Boston, MA **Lat 42.37N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	20/200	N/A	35/300	
FL6(.6)	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/300
FL2.5(.3)	B	10/100	20/100	20/100	N/A	35/200	N/A		N/A
	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/200	N/A	35/200	N/A		
FL(2)5	S	10/100	10/100	20/100	N/A	20/200	N/A	35/300	
Q, FL2(6) or	B	20/100	35/200	35/400	N/A		N/A		
Mo(A)	S	10/100	20/100	35/200	35/200	35/300			
FL4(1)	S	10/100	20/100	20/100	35/200	35/200			
FL2.5(1)	S	10/100	20/200	35/200	35/300				
Iso6 or Iso2	S	20/100	35/200	35/200					
Oc4	S	20/100	35/300						
Fix	S	20/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 3 - Providence, RI **Lat 41.73N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		**.25a**	**.55a**	**.77a**	**1.0a**	**1.15a**	**1.9a**	**2.03a**	**3.0/3.05a**
FL4(.4) or	**B**	10/100	20/100	20/100	N/A	20/200	N/A	35/300	
FL6(.6)	**S**	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/300
FL2.5(.3)	**B**	10/100	20/100	20/100	N/A	35/200	N/A		N/A
	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	**B**	10/100	20/100	20/200	N/A	35/200	N/A		
FL(2)5	**S**	10/100	10/100	20/100	N/A	20/200	N/A	35/300	
Q, FL2(6) or	**B**	20/100	35/200	35/400	N/A		N/A		
Mo(A)	**S**	10/100	20/100	35/200	35/200	35/300			
FL4(1)	**S**	10/100	20/100	20/100	35/200	35/200			
FL2.5(1)	**S**	10/100	20/200	35/200	35/300				
Iso6 or Iso2	**S**	20/100	35/200	35/200					
Oc4	**S**	20/100	35/300						
Fix	**S**	20/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 4 - Bridgeport, CT **Lat 41.17N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		**.25a**	**.55a**	**.77a**	**1.0a**	**1.15a**	**1.9a**	**2.03a**	**3.0/3.05a**
FL4(.4) or	**B**	10/100	20/100	20/100	N/A	20/200	N/A	35/300	
FL6(.6)	**S**	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/300
FL2.5(.3)	**B**	10/100	20/100	20/100	N/A	35/200	N/A		N/A
	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	**B**	10/100	20/100	20/200	N/A	35/200	N/A		
FL(2)5	**S**	10/100	10/100	20/100	N/A	20/200	N/A	35/300	
Q, FL2(6) or	**B**	20/100	35/200	35/300	N/A		N/A		
Mo(A)	**S**	10/100	20/100	35/200	35/200	35/300			
FL4(1)	**S**	10/100	20/100	20/100	35/200				
FL2.5(1)	**S**	10/100	20/200	35/200	35/300				
Iso6 or Iso2	**S**	20/100	35/200	35/300					
Oc4	**S**	20/100	35/300						
Fix	**S**	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 5 - New York, NY **Lat 40.78N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	20/200	N/A	35/300	
FL6(.6)	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/300
FL2.5(.3)	B	10/100	20/100	20/100	N/A	35/200	N/A	35/500	N/A
	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/200	N/A	35/200	N/A		
FL(2)5	S	10/100	10/100	20/100	N/A	20/200	N/A	35/300	
Q, FL2(6) or	B	20/100	35/200	35/300	N/A		N/A		
Mo(A)	S	10/100	20/100	35/200	35/200	35/300			
FL4(1)	S	10/100	20/100	20/100	35/200	35/200			
FL2.5(1)	S	10/100	20/200	35/200	35/300				
Iso6 or Iso2	S	20/100	35/200	35/200					
Oc4	S	20/100	35/300						
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 6 - Albany, NY **Lat 42.75N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	35/200	N/A	35/400	
FL6(.6)	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL2.5(.3)	B	10/100	20/100	20/200	N/A	35/200	N/A		N/A
	S	10/100	10/100	20/100	N/A	20/200	N/A	35/300	N/A
FL(2+1)6 or	B	10/100	20/100	35/200	N/A	35/200	N/A		
FL(2)5	S	10/100	20/100	20/100	N/A	35/200	N/A		
Q, FL2(6) or	B	20/100	35/200	35/500	N/A		N/A		
Mo(A)	S	10/100	35/200	35/200					
FL4(1)	S	10/100	20/100	20/200	35/200	35/200			
FL2.5(1)	S	20/100	35/200	35/200					
Iso6 or Iso2	S	20/100	35/200						
Oc4	S	20/200							
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 7 - Burlington, VT **Lat 44.47N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	35/200	N/A	35/500	
FL6(.6)	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL2.5(.3)	B	10/100	20/100	20/200	N/A	35/200	N/A		N/A
	S	10/100	20/100	20/100	N/A	20/200	N/A		N/A
FL(2+1)6 or	B	20/100	20/200	35/200	N/A	35/200	N/A		
FL(2)5	S	10/100	20/100	20/100	N/A	35/200	N/A		
Q, FL2(6) or	B	20/100	35/200		N/A		N/A		
Mo(A)	S	20/100	35/200	35/200					
FL4(1)	S	10/100	20/100	35/200	35/200	35/300			
FL2.5(1)	S	20/100	35/200	35/300					
Iso6 or Iso2	S	20/100	35/200						
Oc4	S	35/200							
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 8 - Newark, NJ **Lat 40.70N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	20/200	N/A	35/300	
FL6(.6)	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/300
FL2.5(.3)	B	10/100	20/100	20/100	N/A	35/200	N/A		N/A
	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/200	N/A	35/200	N/A		
FL(2)5	S	10/100	10/100	20/100	N/A	20/200	N/A	35/300	
Q, FL2(6) or	B	20/100	35/200	35/300	N/A		N/A		
Mo(A)	S	10/100	20/100	35/200	35/200	35/300			
FL4(1)	S	10/100	20/100	20/100	35/200	35/200			
FL2.5(1)	S	10/100	20/200	35/200	35/300				
Iso6 or Iso2	S	20/100	35/200	35/200					
Oc4	S	20/100	35/300						
Fix	S	20/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 9 - Atlantic City, NJ **Lat 39.45N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL6(.6)	S	10/100	10/100	10/100	N/A	20/100	N/A	20/200	35/200
FL2.5(.3)	B	10/100	20/100	20/100	N/A	35/200	N/A	35/500	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/200	N/A	35/200	N/A		
FL(2)5	S	10/100	20/100	20/100	N/A	35/200	N/A		
Q, FL2(6) or	B	20/100	35/200	35/200	N/A		N/A		
Mo(A)	S	10/100	20/100	35/200	35/200	35/200			
FL4(1)	S	10/100	20/100	20/100	20/200	35/200			
FL2.5(1)	S	10/100	20/100	35/200	35/200				
Iso6 or Iso2	S	20/100	35/200						
Oc4	S	20/100	35/200						
Fix	S	20/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 10 - Wilmington, DE **Lat 39.67N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL6(.6)	S	10/100	10/100	10/100	N/A	20/100	N/A	20/200	35/200
FL2.5(.3)	B	10/100	20/100	20/100	N/A	35/200	N/A	35/500	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/200	N/A	35/200	N/A		
FL(2)5	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	B	20/100	35/200	35/200	N/A		N/A		
Mo(A)	S	10/100	20/100	35/200	35/200	35/200			
FL4(1)	S	10/100	20/100	20/100	35/200	35/200			
FL2.5(1)	S	10/100	20/100	35/200	35/200				
Iso6 or Iso2	S	20/100	35/200	35/200					
Oc4	S	20/100	35/200						
Fix	S	20/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 11 - Philadelphia, PA **Lat 39.88N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	20/100	N/A	20/200	N/A	35/200	
FL6(.6)	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/200
FL2.5(.3)	B	10/100	20/100	20/100	N/A	35/200	N/A	35/500	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/200	N/A	35/200	N/A		
FL(2)5	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	B	20/100	35/200	35/300	N/A		N/A		
Mo(A)	S	10/100	20/100	35/200	35/200	35/200			
FL4(1)	S	10/100	20/100	20/100	35/200	35/200			
FL2.5(1)	S	10/100	20/200	35/200	35/200				
Iso6 or Iso2	S	20/100	35/200						
Oc4	S	20/100	35/200						
Fix	S	20/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 12 - Baltimore, MD **Lat 39.18N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL6(.6)	S	10/100	10/100	10/100	N/A	20/100	N/A	20/200	35/200
FL2.5(.3)	B	10/100	20/100	20/100	N/A	35/200	N/A	35/500	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/100	N/A	35/200	N/A		
FL(2)5	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	B	20/100	35/200	35/200	N/A		N/A		
Mo(A)	S	10/100	20/100	35/200	35/200	35/200			
FL4(1)	S	10/100	20/100	20/100	20/200	35/200			
FL2.5(1)	S	10/100	20/100	35/200	35/200				
Iso6 or Iso2	S	20/100	35/200	35/200					
Oc4	S	20/100	35/200						
Fix	S	20/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 13 - Sterling, VA **Lat 38.95N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°	Lamp Size**							
S-Structure	60°								
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL6(.6)	S	10/100	10/100	10/100	N/A	20/100	N/A	20/200	35/200
FL2.5(.3)	B	10/100	20/100	20/100	N/A	35/200	N/A	35/400	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/100	N/A	35/200	N/A		
FL(2)5	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	B	20/100	35/200	35/200	N/A		N/A		
Mo(A)	S	10/100	20/100	35/200	35/200	35/200			
FL4(1)	S	10/100	20/100	20/100	20/200	35/200			
FL2.5(1)	S	10/100	20/100	35/200	35/200				
Iso6 or Iso2	S	20/100	35/200	35/200					
Oc4	S	20/100	35/200						
Fix	S	20/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 14 - Norfolk, VA **Lat 36.90N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°	Lamp Size**							
S-Structure	60°								
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL6(.6)	S	10/100	10/100	10/100	N/A	20/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	10/100	20/100	N/A	20/200	N/A	35/300	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/100	N/A	35/200	N/A		
FL(2)5	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	B	20/100	35/200	35/200	N/A		N/A		
Mo(A)	S	10/100	20/100	35/200	35/200	35/200			
FL4(1)	S	10/100	20/100	20/100	20/100	35/200	35/300		
FL2.5(1)	S	10/100	20/100	35/200	35/200	35/200			
Iso6 or Iso2	S	10/100	20/200	35/200					
Oc4	S	20/100	35/200						
Fix	S	20/100							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 15 - Cape Hatteras, NC **Lat 35.27N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	35/500
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/100	N/A	35/200	N/A	35/500	
FL(2)5	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	B	10/100	20/200	35/200	N/A	35/300	N/A		
Mo(A)	S	10/100	20/100	20/100	35/200	35/200			
FL4(1)	S	10/100	10/100	20/100	20/100	20/200	35/200	35/200	
FL2.5(1)	S	10/100	20/100	35/200	35/200	35/200			
Iso6 or Iso2	S	10/100	20/100	35/200	35/200				
Oc4	S	20/100	35/200						
Fix	S	20/100	35/200						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 16 - Wilmington, NC **Lat 34.27N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/400
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	20/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/100	N/A	20/200	N/A	35/400	
FL(2)5	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	B	10/100	20/100	35/200	N/A	35/400	N/A		
Mo(A)	S	10/100	20/100	35/200	35/200				
FL4(1)	S	10/100	10/100	20/100	20/100	20/100	35/200	35/200	
FL2.5(1)	S	10/100	20/100	20/200	35/200	35/200			
Iso6 or Iso2	S	10/100	20/100	35/200	35/200				
Oc4	S	20/100	35/200	35/300					
Fix	S	20/100	35/200						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 17 - Charleston, SC **Lat 32.90N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/300
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	20/200	N/A
FL(2+1)6 or	B	10/100	10/100	20/100	N/A	20/200	N/A	35/300	
FL(2)5	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	B	10/100	20/100	35/200	N/A	35/400	N/A		
Mo(A)	S	10/100	20/100	20/100	35/200	35/200			
FL4(1)	S	10/100	10/100	20/100	20/100	20/100	35/200	35/200	
FL2.5(1)	S	10/100	20/100	20/200	35/200	35/200			
Iso6 or Iso2	S	10/100	20/100	35/200	35/200	35/300			
Oc4	S	20/100	35/200	35/200					
Fix	S	20/100	35/200						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 18 - Savannah, GA **Lat 32.13N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/300
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	20/200	N/A
FL(2+1)6 or	B	10/100	10/100	20/100	N/A	20/200	N/A	35/300	
FL(2)5	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	B	10/100	20/100	35/200	N/A	35/300	N/A		
Mo(A)	S	10/100	20/100	20/100	35/200	35/200			
FL4(1)	S	10/100	10/100	20/100	20/100	20/100	35/200	35/200	
FL2.5(1)	S	10/100	20/100	20/200	35/200	35/200			
Iso6 or Iso2	S	10/100	20/100	35/200	35/200				
Oc4	S	20/100	35/200	35/200					
Fix	S	20/100	35/200						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 19 - Jacksonville, FL **Lat 30.50N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/200
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	20/200	N/A
FL(2+1)6 or	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL(2)5	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	B	10/100	20/100	35/200	N/A	35/300	N/A		
Mo(A)	S	10/100	20/100	20/100	35/200	35/200			
FL4(1)	S	10/100	10/100	20/100	20/100	20/100	35/200	35/200	
FL2.5(1)	S	10/100	20/100	20/200	35/200	35/200			
Iso6 or Iso2	S	10/100	20/100	35/200	35/200	35/300			
Oc4	S	20/100	35/200	35/200					
Fix	S	20/100	35/200						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 20 - Daytona Beach, FL **Lat 29.18N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	20/100	N/A	20/200	35/200
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	20/100	N/A
FL(2+1)6 or	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL(2)5	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/300
Q, FL2(6) or	B	10/100	20/100	35/200	N/A		N/A		
Mo(A)	S	10/100	20/100	20/100	35/200	35/200			
FL4(1)	S	10/100	10/100	20/100	20/100	20/100	35/200	35/200	
FL2.5(1)	S	10/100	20/100	20/200	35/200	35/200			
Iso6 or Iso2	S	10/100	20/100	35/200	35/200	35/200			
Oc4	S	20/100	35/200	35/200					
Fix	S	20/100	35/200						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 21 - West Palm Beach, FL **Lat 26.68N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	20/100	N/A	20/200	35/200
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	20/100	N/A
FL(2+1)6 or	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL(2)5	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/300
Q, FL2(6) or	B	10/100	20/100	20/200	N/A	35/200	N/A		
Mo(A)	S	10/100	20/100	20/100	35/200	35/200			
FL4(1)	S	10/100	10/100	20/100	20/100	20/100	35/200	35/200	
FL2.5(1)	S	10/100	20/100	20/100	35/200	35/200			
Iso6 or Iso2	S	10/100	20/100	35/200	35/200				
Oc4	S	20/100	35/200	35/200					
Fix	S	20/100	35/200						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 22 - Miami, FL **Lat 25.80N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	20/100	N/A	20/100	35/200
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	20/100	N/A
FL(2+1)6 or	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL(2)5	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/200
Q, FL2(6) or	B	10/100	20/100	20/100	N/A	35/200	N/A		
Mo(A)	S	10/100	20/100	20/100	20/100	35/200			
FL4(1)	S	10/100	10/100	20/100	20/100	20/100	35/200	35/200	
FL2.5(1)	S	10/100	20/100	20/100	35/200	35/200			
Iso6 or Iso2	S	10/100	20/100	35/200	35/200	35/200			
Oc4	S	20/100	35/200	35/200					
Fix	S	20/100	35/200						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 23 - San Juan PR **Lat 18.43N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	30°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	20/100
FL2.5(.3)	B	10/100	10/100	10/100	N/A	10/100	N/A	20/100	N/A
	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	N/A
FL(2+1)6 or	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/300
FL(2)5	S	10/100	10/100	10/100	N/A	20/100	N/A	20/100	35/200
Q, FL2(6) or	B	10/100	20/100	20/100	N/A	35/200	N/A		
Mo(A)	S	10/100	10/100	20/100	20/100	20/100	35/200	35/300	
FL4(1)	S	10/100	10/100	10/100	20/100	20/100	35/200	35/200	
FL2.5(1)	S	10/100	20/100	20/100	20/100	35/200			
Iso6 or Iso2	S	10/100	20/100	20/100	35/200	35/200			
Oc4	S	10/100	20/100	35/200	35/200				
Fix	S	20/100	35/200	35/200					

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 24 -Key West, FL **Lat 24.55N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	N/A
FL(2+1)6 or	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	
FL(2)5	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/200
Q, FL2(6) or	B	10/100	20/100	20/100	N/A	35/200	N/A		
Mo(A)	S	10/100	20/100	20/100	20/100	35/200	35/200		
FL4(1)	S	10/100	10/100	20/100	20/100	20/100	35/200	35/200	
FL2.5(1)	S	10/100	20/100	20/100	35/200	35/200			
Iso6 or Iso2	S	10/100	20/100	35/200	35/200	35/200			
Oc4	S	10/100	35/200	35/200					
Fix	S	20/100	35/200						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 25 - Tampa, FL **Lat 27.97N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	20/100	N/A	20/200	35/200
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	N/A
FL(2+1)6 or	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL(2)5	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/200
Q, FL2(6) or	B	10/100	20/100	20/200	N/A	35/200	N/A		
Mo(A)	S	10/100	20/100	20/100	20/100	35/200			
FL4(1)	S	10/100	10/100	20/100	20/100	20/100	35/200	35/200	
FL2.5(1)	S	10/100	20/100	20/100	35/200	35/200			
Iso6 or Iso2	S	10/100	20/100	35/200	35/200	35/200			
Oc4	S	20/100	35/200	35/200					
Fix	S	20/100	35/200						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 26 - Tallahassee, FL **Lat 30.38N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/200
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	20/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/100	N/A	35/200	N/A		
FL(2)5	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	B	10/100	20/100	35/200	N/A	35/200	N/A		
Mo(A)	S	10/100	20/100	20/100	35/200	35/200			
FL4(1)	S	10/100	10/100	20/100	20/100	20/100	35/200	35/200	
FL2.5(1)	S	10/100	20/100	20/100	35/200	35/200			
Iso6 or Iso2	S	10/100	20/100	35/200	35/200	35/300			
Oc4	S	20/100	35/200	35/200					
Fix	S	20/100	35/200						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 27 - Mobile, AL **Lat 30.68N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/200
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	10/100	20/100	N/A	20/200	N/A	35/300	
FL(2)5	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	B	10/100	20/100	35/200	N/A	35/400	N/A		
Mo(A)	S	10/100	20/100	20/100	35/200	35/200			
FL4(1)	S	10/100	20/100	20/100	20/100	20/200	35/200	35/300	
FL2.5(1)	S	10/100	20/100	35/200	35/200	35/200			
Iso6 or Iso2	S	10/100	20/100	35/200	35/200				
Oc4	S	20/100	35/200						
Fix	S	20/100	35/300						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 28 - New Orleans, LA **Lat 29.98N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/300
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	10/100	20/100	N/A	20/200	N/A	35/300	
FL(2)5	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	B	10/100	20/100	35/200	N/A	35/300	N/A		
Mo(A)	S	10/100	20/100	20/100	35/200	35/200			
FL4(1)	S	10/100	10/100	20/100	20/100	20/200	35/200	35/300	
FL2.5(1)	S	10/100	20/100	35/200	35/200	35/200			
Iso6 or Iso2	S	10/100	20/100	35/200	35/200				
Oc4	S	20/100	35/200						
Fix	S	20/100	35/200						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 29 - Port Arthur, TX **Lat 29.95N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/300
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	10/100	20/100	N/A	20/200	N/A	35/300	
FL(2)5	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	B	10/100	20/100	35/200	N/A	35/300	N/A		
Mo(A)	S	10/100	20/100	20/100	35/200	35/200			
FL4(1)	S	10/100	20/100	20/100	20/100	20/200	35/200	35/300	
FL2.5(1)	S	10/100	20/100	35/200	35/200	35/200			
Iso6 or Iso2	S	10/100	20/100	35/200	35/200				
Oc4	S	20/100	35/200						
Fix	S	20/100	35/300						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 30 - Houston, TX **Lat 29.98N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/300
FL6(.6)	S	10/100	10/100	10/100	N/A	20/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/100	N/A	20/200	N/A	35/300	
FL(2)5	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	B	10/100	20/100	35/200	N/A	35/400	N/A		
Mo(A)	S	10/100	20/100	20/100	35/200	35/200			
FL4(1)	S	10/100	20/100	20/100	20/100	35/200	35/300		
FL2.5(1)	S	10/100	20/100	35/200	35/200	35/200			
Iso6 or Iso2	S	10/100	20/200	35/200	35/300				
Oc4	S	20/100	35/200						
Fix	S	20/100	35/300						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 31 - Corpus Cristi, TX **Lat 27.77N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/200
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL(2)5	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	B	10/100	20/100	35/200	N/A	35/300	N/A		
Mo(A)	S	10/100	20/100	20/100	35/200	35/200			
FL4(1)	S	10/100	20/100	20/100	20/100	20/200	35/200	35/300	
FL2.5(1)	S	10/100	20/100	35/200	35/200	35/200			
Iso6 or Iso2	S	10/100	20/100	35/200	35/200				
Oc4	S	20/100	35/200						
Fix	S	20/100	35/300						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 32 - Brownsville, TX **Lat 25.90N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/200
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL(2)5	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	B	10/100	20/100	35/200	N/A	35/200	N/A		
Mo(A)	S	10/100	20/100	20/100	35/200	35/200			
FL4(1)	S	10/100	20/100	20/100	20/100	20/200	35/200	35/300	
FL2.5(1)	S	10/100	20/100	35/200	35/200	35/200			
Iso6 or Iso2	S	10/100	20/200	35/200	35/300				
Oc4	S	20/100	35/200						
Fix	S	20/100	35/300						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 33 - Little Rock, AR Lat 34.73N

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	35/500
FL6(.6)	S	10/100	10/100	10/100	N/A	20/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/100	N/A	35/200	N/A	35/500	
FL(2)5	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	B	10/100	20/200	35/200	N/A	35/500	N/A		
Mo(A)	S	10/100	20/100	20/100	35/200	35/200			
FL4(1)	S	20/100	20/100	35/200	35/300				
FL2.5(1)	S	10/100	20/100	20/100	20/100				
Iso6 or Iso2	S	20/200	35/200	35/300					
Oc4	S	20/100	35/200						
Fix	S	20/100	35/300						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 34 - Fort Smith, AR Lat 35.33N

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/500
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/100	N/A	35/200	N/A	35/500	
FL(2)5	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	B	10/100	20/200	35/200	N/A	35/500	N/A		
Mo(A)	S	10/100	20/100	20/100	35/200	35/200			
FL4(1)	S	10/100	10/100	20/100	20/100	20/200	35/200	35/300	
FL2.5(1)	S	10/100	20/100	35/200	35/200	35/200			
Iso6 or Iso2	S	10/100	20/100	35/200	35/200				
Oc4	S	20/100	35/200						
Fix	S	20/100	35/200						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 35 - Oklahoma City, OK **Lat 35.40N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		**.25a**	**.55a**	**.77a**	**1.0a**	**1.15a**	**1.9a**	**2.03a**	**3.0/3.05a**
FL4(.4) or	**B**	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/400
FL6(.6)	**S**	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(.3)	**B**	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	20/200	N/A
FL(2+1)6 or	**B**	10/100	20/100	20/100	N/A	20/200	N/A	35/400	
FL(2)5	**S**	10/100	10/100	10/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	**B**	10/100	20/100	35/200	N/A	35/400	N/A		
Mo(A)	**S**	10/100	20/100	20/100	35/200	35/200			
FL4(1)	**S**	10/100	20/100	20/100	20/100	20/100	35/200	35/200	
FL2.5(1)	**S**	10/100	20/100	20/100	35/200	35/200			
Iso6 or Iso2	**S**	10/100	20/100	35/200	35/200	35/300			
Oc4	**S**	20/100	35/200	35/200					
Fix	**S**	20/100	35/200						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 36 - Memphis, TN **Lat 35.05N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		**.25a**	**.55a**	**.77a**	**1.0a**	**1.15a**	**1.9a**	**2.03a**	**3.0/3.05a**
FL4(.4) or	**B**	10/100	10/100	20/100	N/A	20/100	N/A	35/200	35/500
FL6(.6)	**S**	10/100	10/100	10/100	N/A	20/100	N/A	20/100	35/200
FL2.5(.3)	**B**	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	**B**	10/100	20/100	20/100	N/A	35/200	N/A		
FL(2)5	**S**	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	**B**	10/100	20/200	35/200	N/A		N/A		
Mo(A)	**S**	10/100	20/100	20/200	35/200	35/200			
FL4(1)	**S**	10/100	20/100	20/100	20/200	35/200	35/300		
FL2.5(1)	**S**	10/100	20/100	35/200	35/200	35/200			
Iso6 or Iso2	**S**	10/100	20/200	35/200					
Oc4	**S**	20/100	35/200						
Fix	**S**	20/100							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 37 - Huntsville, AL **Lat 34.65N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		**.25a**	**.55a**	**.77a**	**1.0a**	**1.15a**	**1.9a**	**2.03a**	**3.0/3.05a**
FL4(.4) or	**B**	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL6(.6)	**S**	10/100	10/100	10/100	N/A	20/100	N/A	20/200	35/200
FL2.5(.3)	**B**	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	**B**	10/100	20/100	20/100	N/A	35/200	N/A		
FL(2)5	**S**	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	**B**	20/100	20/200	35/200	N/A		N/A		
Mo(A)	**S**	10/100	20/100	20/200	35/200	35/200			
FL4(1)	**S**	10/100	20/100	20/100	20/200	35/200			
FL2.5(1)	**S**	10/100	20/100	35/200	35/200	35/300			
Iso6 or Iso2	**S**	20/100	35/200	35/200					
Oc4	**S**	20/100	35/200						
Fix	**S**	20/100							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 38 - Chattanooga, TN **Lat 35.03N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		**.25a**	**.55a**	**.77a**	**1.0a**	**1.15a**	**1.9a**	**2.03a**	**3.0/3.05a**
FL4(.4) or	**B**	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL6(.6)	**S**	10/100	10/100	10/100	N/A	20/100	N/A	20/200	35/200
FL2.5(.3)	**B**	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	**B**	10/100	20/100	20/100	N/A	35/200	N/A		
FL(2)5	**S**	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	**B**	20/100	20/200	35/200	N/A		N/A		
Mo(A)	**S**	10/100	20/100	20/200	35/200	35/200			
FL4(1)	**S**	10/100	20/100	20/100	20/200	35/200			
FL2.5(1)	**S**	10/100	20/100	35/200	35/200	35/300			
Iso6 or Iso2	**S**	20/100	35/200	35/200					
Oc4	**S**	20/100	35/200						
Fix	**S**	20/100							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 39 - St Louis, MO **Lat 38.75N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL6(.6)	S	10/100	10/100	10/100	N/A	20/100	N/A	20/200	35/200
FL2.5(.3)	B	10/100	20/100	20/100	N/A	20/200	N/A	35/400	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/100	N/A	35/200	N/A		
FL(2)5	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	B	20/100	35/200	35/200	N/A		N/A		
Mo(A)	S	10/100	20/100	35/200	35/200	35/200			
FL4(1)	S	10/100	20/100	20/100	35/200	35/200			
FL2.5(1)	S	10/100	20/200	35/200	35/200				
Iso6 or Iso2	S	20/100	35/200	35/200					
Oc4	S	20/100	35/200						
Fix	S	20/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 40 - Kansas City, MO **Lat 39.30N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL6(.6)	S	10/100	10/100	10/100	N/A	20/100	N/A	20/200	35/200
FL2.5(.3)	B	10/100	20/100	20/100	N/A	20/200	N/A	35/400	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/100	N/A	35/200	N/A		
FL(2)5	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	B	20/100	35/200	35/200	N/A		N/A		
Mo(A)	S	10/100	20/100	20/200	35/200	35/200			
FL4(1)	S	10/100	20/100	20/100	20/200	35/200			
FL2.5(1)	S	10/100	20/200	35/200	35/200	35/300			
Iso6 or Iso2	S	20/100	35/200	35/200					
Oc4	S	20/100	35/200						
Fix	S	20/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 41 - Moline, IL **Lat 41.45N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	20/200	N/A	35/300	
FL6(.6)	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/300
FL2.5(.3)	B	10/100	20/100	20/100	N/A	20/200	N/A		N/A
	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/200	N/A	35/200	N/A		
FL(2)5	S	10/100	10/100	20/100	N/A	20/200	N/A	35/300	
Q, FL2(6) or	B	20/100	35/200	35/400	N/A		N/A		
Mo(A)	S	10/100	20/100	35/200	35/200				
FL4(1)	S	10/100	20/100	20/200	35/200	35/200			
FL2.5(1)	S	20/100	20/200	35/200					
Iso6 or Iso2	S	20/100	35/200	35/300					
Oc4	S	20/100	35/300						
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 42 - Minneapolis, MN **Lat 44.88N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	35/200	N/A	35/500	
FL6(.6)	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	
FL2.5(.3)	B	10/100	20/100	20/200	N/A	35/200	N/A		N/A
	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	35/200	N/A	35/200	N/A		
FL(2)5	S	10/100	20/100	20/100	N/A	20/200	N/A		
Q, FL2(6) or	B	20/100	35/200	35/500	N/A		N/A		
Mo(A)	S	10/100	20/200	35/200	35/300				
FL4(1)	S	10/100	20/100	20/200	35/200	35/200			
FL2.5(1)	S	20/100	35/200	35/200					
Iso6 or Iso2	S	20/100	35/200						
Oc4	S	20/100							
Fix	S	20/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1 9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 43 - Evansville, IN **Lat 38.05N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL6(.6)	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/200
FL2.5(.3)	B	10/100	20/100	20/100	N/A	35/200	N/A	35/400	N/A
	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/100	N/A	35/200	N/A		
FL(2)5	S	10/100	10/100	20/100	N/A	20/200	N/A	35/300	
Q, FL2(6) or	B	20/100	35/200	35/200	N/A		N/A		
Mo(A)	S	10/100	20/100	35/200	35/200	35/300			
FL4(1)	S	10/100	20/100	20/100	35/200	35/200			
FL2.5(1)	S	10/100	20/200	35/200	35/300				
Iso6 or Iso2	S	20/100	35/200	35/200					
Oc4	S	20/100	35/300						
Fix	S	20/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 44 - Indianapolis, IN **Lat 39.73N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	20/200	N/A	35/300	
FL6(.6)	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	
FL2.5(.3)	B	10/100	20/100	20/100	N/A	35/200	N/A		N/A
	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/200	N/A	35/200	N/A		
FL(2)5	S	10/100	20/100	20/100	N/A	20/200	N/A		
Q, FL2(6) or	B	20/100	35/200	35/300	N/A		N/A		
Mo(A)	S	10/100	20/200	35/200	35/300				
FL4(1)	S	10/100	20/100	20/200	35/200	35/200			
FL2.5(1)	S	20/100	35/200	35/200					
Iso6 or Iso2	S	20/100	35/200						
Oc4	S	20/200							
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 45 - Louisville, KY **Lat 38.18N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°	Lamp Size**							
S-Structure	60°								
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL6(.6)	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/300
FL2.5(.3)	B	10/100	20/100	20/100	N/A	35/200	N/A		N/A
	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/200	N/A	35/200	N/A		
FL(2)5	S	10/100	10/100	20/100	N/A	20/200	N/A	35/300	
Q, FL2(6) or	B	20/100	35/200		N/A		N/A		
Mo(A)	S	10/100	20/100	35/200	35/200	35/300			
FL4(1)	S	10/100	20/100	20/100	35/200	35/200			
FL2.5(1)	S	20/100	20/200	35/200					
Iso6 or Iso2	S	20/100	35/200	35/300					
Oc4	S	20/100	35/300						
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 46 - Cincinnati, OH **Lat 39.07N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°	Lamp Size**							
S-Structure	60°								
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	20/200	N/A	35/200	
FL6(.6)	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	
FL2.5(.3)	B	10/100	20/100	20/100	N/A	35/200	N/A	35/500	N/A
	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/200	N/A	35/200	N/A		
FL(2)5	S	10/100	20/100	20/100	N/A	20/200	N/A		
Q, FL2(6) or	B	20/100	35/200	35/300	N/A		N/A		
Mo(A)	S	10/100	20/200	35/200	35/300				
FL4(1)	S	10/100	20/100	20/200	35/200	35/200			
FL2.5(1)	S	20/100	35/200	35/200					
Iso6 or Iso2	S	20/100	35/200						
Oc4	S	20/100							
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 47 - Pittsburg, PA **Lat 40.50N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	35/200	N/A	35/400	
FL6(.6)	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL2.5(.3)	B	10/100	20/100	20/100	N/A	35/200	N/A		N/A
	S	10/100	20/100	20/100	N/A	20/200	N/A	35/300	N/A
FL(2+1)6 or	B	10/100	20/100	35/200	N/A	35/200	N/A		
FL(2)5	S	10/100	20/100	20/100	N/A	35/200	N/A		
Q, FL2(6) or	B	20/100	35/200	35/400	N/A		N/A		
Mo(A)	S	20/100	35/200	35/200					
FL4(1)	S	10/100	20/100	35/200	35/200	35/200			
FL2.5(1)	S	20/100	35/200	35/300					
Iso6 or Iso2	S	20/100	35/200						
Oc4	S	20/200							
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 48 - Massena, NY **Lat 44.93N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	35/200	N/A	35/500	
FL6(.6)	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL2.5(.3)	B	10/100	20/100	35/200	N/A	35/200	N/A		N/A
	S	10/100	20/100	20/100	N/A	20/200	N/A	35/300	N/A
FL(2+1)6 or	B	10/100	20/100	35/200	N/A	35/200	N/A		
FL(2)5	S	10/100	20/100	20/100	N/A	35/200	N/A		
Q, FL2(6) or	B	20/100	35/200		N/A		N/A		
Mo(A)	S	20/100	20/200	35/200					
FL4(1)	S	10/100	20/100	35/200	35/300				
FL2.5(1)	S	20/100	35/200	35/300					
Iso6 or Iso2	S	20/100	35/200						
Oc4	S	20/200							
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1 0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 49 - Rochester, NY **Lat 43.12N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		**.25a**	**.55a**	**.77a**	**1.0a**	**1.15a**	**1.9a**	**2.03a**	**3.0/3.05a**
FL4(.4) or	**B**	10/100	20/100	20/100	N/A	35/200	N/A	35/500	
FL6(.6)	**S**	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL2.5(.3)	**B**	10/100	20/100	20/200	N/A	35/200	N/A		N/A
	S	10/100	20/100	20/100	N/A	20/200	N/A		N/A
FL(2+1)6 or	**B**	10/100	20/100	35/200	N/A	35/200	N/A		
FL(2)5	**S**	10/100	20/100	20/200	N/A	35/200	N/A		
Q, FL2(6) or	**B**	20/100	35/200	35/500	N/A		N/A		
Mo(A)	**S**	20/100	35/200	35/200					
FL4(1)	**S**	10/100	20/200	35/200	35/200	35/300			
FL2.5(1)	**S**	20/100	35/200						
Iso6 or Iso2	**S**	20/100	35/300						
Oc4	**S**	35/200							
Fix	**S**	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 50 - Buffalo, NY **Lat 42.93N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		**.25a**	**.55a**	**.77a**	**1.0a**	**1.15a**	**1.9a**	**2.03a**	**3.0/3.05a**
FL4(.4) or	**B**	10/100	20/100	20/100	N/A	35/200	N/A	35/500	
FL6(.6)	**S**	10/100	10/100	20/100	N/A	20/200	N/A	35/200	
FL2.5(.3)	**B**	10/100	20/100	20/200	N/A	35/200	N/A		N/A
	S	10/100	20/100	20/100	N/A	35/200	N/A		N/A
FL(2+1)6 or	**B**	10/100	20/100	35/200	N/A	35/200	N/A		
FL(2)5	**S**	10/100	20/100	20/200	N/A		N/A		
Q, FL2(6) or	**B**	20/100	35/200		N/A		N/A		
Mo(A)	**S**	20/100	35/200	35/300					
FL4(1)	**S**	10/100	20/200	35/200	35/200				
FL2.5(1)	**S**	20/100	35/200						
Iso6 or Iso2	**S**	20/100	35/300						
Oc4	**S**	35/200							
Fix	**S**	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 51 - Erie, PA **Lat 42.08N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	35/200	N/A	35/500	
FL6(.6)	S	10/100	10/100	20/100	N/A	20/200	N/A	35/200	
FL2.5(.3)	B	10/100	20/100	20/200	N/A	35/200	N/A		N/A
	S	10/100	20/100	20/100	N/A	35/200	N/A		N/A
FL(2+1)6 or	B	10/100	20/100	35/200	N/A	35/200	N/A		
FL(2)5	S	10/100	20/100	20/200	N/A	35/200	N/A		
Q, FL2(6) or	B	20/100	35/200	35/500	N/A		N/A		
Mo(A)	S	20/100	35/200	35/300					
FL4(1)	S	10/100	20/200	35/200	35/200				
FL2.5(1)	S	20/100	35/200						
Iso6 or Iso2	S	20/100	35/300						
Oc4	S	35/200							
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 52 - Cleveland, OH **Lat 41.40N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	35/200	N/A	35/500	
FL6(.6)	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL2.5(.3)	B	10/100	20/100	20/200	N/A	35/200	N/A		N/A
	S	10/100	20/100	20/100	N/A	20/200	N/A		N/A
FL(2+1)6 or	B	10/100	20/100	35/200	N/A	35/200	N/A		
FL(2)5	S	10/100	20/100	20/200	N/A	35/200	N/A		
Q, FL2(6) or	B	20/100	35/200	35/500	N/A		N/A		
Mo(A)	S	20/100	35/200	35/200					
FL4(1)	S	10/100	20/200	35/200	35/200	35/300			
FL2.5(1)	S	20/100	35/200						
Iso6 or Iso2	S	20/100	35/300						
Oc4	S	20/200							
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1 9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 53 - Toledo, OH **Lat 41.60N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	35/200	N/A	35/400	
FL6(.6)	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL2.5(.3)	B	10/100	20/100	20/200	N/A	35/200	N/A		N/A
	S	10/100	10/100	20/100	N/A	20/200	N/A	35/300	N/A
FL(2+1)6 or	B	10/100	20/100	35/200	N/A	35/200	N/A		
FL(2)5	S	10/100	20/100	20/100	N/A	35/200	N/A		
Q, FL2(6) or	B	20/100	35/200	35/500	N/A		N/A		
Mo(A)	S	20/100	20/200	35/200					
FL4(1)	S	10/100	20/100	35/200	35/200	35/200			
FL2.5(1)	S	20/100	35/200	35/300					
Iso6 or Iso2	S	20/100	35/200						
Oc4	S	20/200							
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 54 - Detroit, MI **Lat 42.42N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	35/200	N/A	35/500	
FL6(.6)	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL2.5(.3)	B	10/100	20/100	20/200	N/A	35/200	N/A		N/A
	S	10/100	10/100	20/100	N/A	20/200	N/A	35/300	N/A
FL(2+1)6 or	B	10/100	20/100	35/200	N/A	35/300	N/A		
FL(2)5	S	10/100	20/100	20/100	N/A	35/200	N/A		
Q, FL2(6) or	B	20/100	35/200	35/500	N/A		N/A		
Mo(A)	S	20/100	35/200	35/200					
FL4(1)	S	10/100	20/100	35/200	35/200	35/300			
FL2.5(1)	S	20/100	35/200	35/300					
Iso6 or Iso2	S	20/100	35/200						
Oc4	S	35/200							
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 55 - Alpena, MI Lat 45.07N

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	35/200	N/A		
FL6(.6)	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL2.5(.3)	B	10/100	20/100	20/200	N/A	35/200	N/A		N/A
	S	10/100	20/100	20/100	N/A	20/200	N/A		N/A
FL(2+1)6 or	B	20/100	20/200	35/200	N/A	35/400	N/A		
FL(2)5	S	10/100	20/100	20/200	N/A	35/200	N/A		
Q, FL2(6) or	B	20/100	35/200		N/A		N/A		
Mo(A)	S	20/100	35/200	35/200					
FL4(1)	S	10/100	20/200	35/200	35/200	35/300			
FL2.5(1)	S	20/100	35/200						
Iso6 or Iso2	S	20/100	35/300						
Oc4	S	35/200							
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 56 - Traverse City, MI Lat 44.73N

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	35/200	N/A		
FL6(.6)	S	10/100	10/100	20/100	N/A	20/200	N/A	35/300	
FL2.5(.3)	B	10/100	10/100	20/200	N/A	35/200	N/A		N/A
	S	10/100	20/100	20/100	N/A	35/200	N/A		N/A
FL(2+1)6 or	B	20/100	20/200	35/200	N/A	35/400	N/A		
FL(2)5	S	10/100	20/100	20/200	N/A	35/200	N/A		
Q, FL2(6) or	B	20/100	35/300		N/A		N/A		
Mo(A)	S	20/100	35/200	35/300					
FL4(1)	S	20/100	20/200	35/200	35/300				
FL2.5(1)	S	20/100	35/200						
Iso6 or Iso2	S	20/100	35/300						
Oc4	S	35/200							
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 57 - Muskegon, MI **Lat 43.17N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	35/200	N/A	35/500	
FL6(.6)	S	10/100	10/100	20/100	N/A	20/200	N/A	35/200	
FL2.5(.3)	B	10/100	20/100	20/200	N/A	35/200	N/A		N/A
	S	10/100	20/100	20/100	N/A	35/200	N/A		N/A
FL(2+1)6 or	B	10/100	20/200	35/200	N/A	35/300	N/A		
FL(2)5	S	10/100	20/100	20/200	N/A	35/200	N/A		
Q, FL2(6) or	B	20/100	35/200		N/A		N/A		
Mo(A)	S	20/100	35/200	35/300					
FL4(1)	S	20/100	20/200	35/200	35/300				
FL2.5(1)	S	20/100	35/200						
Iso6 or Iso2	S	20/100	35/300						
Oc4	S	35/200							
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 58 - Chicago, IL **Lat 41.78N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	20/200	N/A	35/400	
FL6(.6)	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	
FL2.5(.3)	B	10/100	20/100	20/100	N/A	35/200	N/A		N/A
	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/200	35/200	N/A	35/200	N/A		
FL(2)5	S	10/100	20/100	20/100	N/A	35/200	N/A		
Q, FL2(6) or	B	20/100	35/200	35/400	N/A		N/A		
Mo(A)	S	10/100	20/200	35/200	35/300				
FL4(1)	S	10/100	20/100	20/200	35/200	35/200			
FL2.5(1)	S	20/100	35/200	35/200					
Iso6 or Iso2	S	20/100	35/200						
Oc4	S	20/200							
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1 0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 59 - Milwaukee, WI **Lat 42.95N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	35/200	N/A	35/400	
FL6(.6)	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL2.5(.3)	B	10/100	20/100	20/100	N/A	35/200	N/A		N/A
	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	35/200	N/A	35/200	N/A		
FL(2)5	S	10/100	20/100	20/100	N/A	35/200	N/A		
Q, FL2(6) or	B	20/100	35/200	35/500	N/A		N/A		
Mo(A)	S	10/100	20/200	35/200	35/300				
FL4(1)	S	10/100	20/100	20/200	35/200	35/200			
FL2.5(1)	S	20/100	35/200	35/200					
Iso6 or Iso2	S	20/100	35/200						
Oc4	S	20/200							
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 60 - Green Bay, WI **Lat 44.48N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	35/200	N/A	35/500	
FL6(.6)	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL2.5(.3)	B	10/100	20/100	20/200	N/A	35/200	N/A		N/A
	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	35/200	N/A	35/300	N/A		
FL(2)5	S	10/100	20/100	20/100	N/A	35/200	N/A		
Q, FL2(6) or	B	20/100	35/200	35/500	N/A		N/A		
Mo(A)	S	10/100	20/200	35/200	35/300				
FL4(1)	S	10/100	20/100	20/200	35/200	35/200			
FL2.5(1)	S	20/100	35/200	35/200					
Iso6 or Iso2	S	20/100	35/200						
Oc4	S	20/200							
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns

SOLAR SIZING TABLE - 61 - Sault Ste Marie, MI **Lat 46.47N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	35/200	N/A		
FL6(.6)	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL2.5(.3)	B	10/100	20/100	20/200	N/A	35/200	N/A		N/A
	S	10/100	20/100	20/100	N/A	20/200	N/A		N/A
FL(2+1)6 or	B	20/100	20/200	35/200	N/A	35/400	N/A		
FL(2)5	S	10/100	20/100	20/100	N/A	35/200	N/A		
Q, FL2(6) or	B	20/100	35/300		N/A		N/A		
Mo(A)	S	20/100	35/200	35/200					
FL4(1)	S	10/100	20/200	35/200	35/200	35/300			
FL2.5(1)	S	20/100	35/200						
Iso6 or Iso2	S	20/100	35/300						
Oc4	S	35/200							
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 62 - Houghton, MI **Lat 47.17N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/200	N/A	35/200	N/A		
FL6(.6)	S	10/100	20/100	20/100	N/A	20/200	N/A	35/300	
FL2.5(.3)	B	20/100	20/200	35/200	N/A	35/300	N/A		N/A
	S	10/100	20/100	20/100	N/A	35/200	N/A		N/A
FL(2+1)6 or	B	20/100	35/200	35/200	N/A	35/500	N/A		
FL(2)5	S	10/100	20/100	20/200	N/A	35/200	N/A		
Q, FL2(6) or	B	20/200	35/400		N/A		N/A		
Mo(A)	S	20/100	35/200						
FL4(1)	S	20/100	20/200	35/200	35/300				
FL2.5(1)	S	20/100	35/200						
Iso6 or Iso2	S	20/200							
Oc4	S	35/200							
Fix	S	35/300							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 63 - Duluth, MI **Lat 46.83N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	35/200	N/A		
FL6(.6)	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL2.5(.3)	B	10/100	20/100	20/200	N/A	35/200	N/A		N/A
	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	20/100	20/200	35/200	N/A	35/400	N/A		
FL(2)5	S	10/100	20/100	20/100	N/A	35/200	N/A		
Q, FL2(6) or	B	20/100	35/200		N/A		N/A		
Mo(A)	S	10/100	20/200	35/200					
FL4(1)	S	10/100	20/100	20/200	35/200	35/200			
FL2.5(1)	S	20/100	35/200	35/200					
Iso6 or Iso2	S	20/100	35/200						
Oc4	S	20/200							
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 64 - International Falls, MN **Lat 48.57N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	35/200	N/A		
FL6(.6)	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL2.5(.3)	B	10/100	20/100	35/200	N/A	35/200	N/A		N/A
	S	10/100	20/100	20/200	N/A	35/300	N/A		N/A
FL(2+1)6 or	B	20/100	20/200	35/200	N/A	35/500	N/A		
FL(2)5	S	10/100	20/100	20/100	N/A	35/200	N/A		
Q, FL2(6) or	B	20/200	35/400		N/A		N/A		
Mo(A)	S	20/100	35/200	35/200					
FL4(1)	S	10/100	20/100	35/200	35/200	35/300			
FL2.5(1)	S	20/100	35/200	35/300					
Iso6 or Iso2	S	20/100	35/200						
Oc4	S	35/200							
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 65 - Salt Lake City, UT **Lat 40.77N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	20/200	N/A	35/300	
FL6(.6)	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/300
FL2.5(3)	B	10/100	20/100	20/100	N/A	35/200	N/A		N/A
	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/200	N/A	35/200	N/A		
FL(2)5	S	10/100	10/100	20/100	N/A	20/200	N/A	35/300	
Q, FL2(6) or	B	20/100	35/200	35/300	N/A		N/A		
Mo(A)	S	10/100	10/100	20/100	35/200	35/300			
FL4(1)	S	10/100	20/100	20/100	35/200	35/200			
FL2.5(1)	S	10/100	20/200	35/200	35/300				
Iso6 or Iso2	S	20/100	35/200	35/300					
Oc4	S	20/100	35/300						
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 66 - Reno, NV **Lat 39.50N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	20/100	20/100	N/A	20/200	N/A	35/300	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/100	N/A	35/200	N/A		
FL(2)5	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	B	20/100	35/200	35/200	N/A		N/A		
Mo(A)	S	10/100	20/100	20/100	35/200	35/200			
FL4(1)	S	10/100	20/100	20/100	20/100	20/200	35/200	35/300	
FL2.5(1)	S	10/100	20/100	35/200	35/200	35/200			
Iso6 or Iso2	S	10/100	20/100	35/200	35/200				
Oc4	S	20/100	35/200						
Fix	S	20/100	35/300						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1 9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 67 - Las Vegas, NV **Lat 36.08N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/200
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	20/200
FL2.5(.3)	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	N/A
FL(2+1)6 or	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL(2)5	S	10/100	10/100	10/100	N/A	20/100	N/A	20/200	35/200
Q, FL2(6) or	B	10/100	20/100	35/200	N/A	35/200	N/A		
Mo(A)	S	10/100	10/100	20/100	20/100	20/200	35/300		
FL4(1)	S	10/100	10/100	20/100	20/100	20/100	35/200	35/200	
FL2.5(1)	S	10/100	20/100	20/100	20/200	35/200			
Iso6 or Iso2	S	10/100	20/100	20/100	35/200	35/200			
Oc4	S	10/100	20/200	35/200	35/300				
Fix	S	20/100	35/200	35/300					

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 68 - San Diego, CA **Lat 32.73N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/200
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	N/A
FL(2+1)6 or	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL(2)5	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/200
Q, FL2(6) or	B	10/100	20/100	35/200	N/A	35/200	N/A		
Mo(A)	S	10/100	20/100	20/100	20/100	35/200			
FL4(1)	S	10/100	10/100	20/100	20/100	20/100	35/200	35/200	
FL2.5(1)	S	10/100	20/100	20/100	35/200	35/200			
Iso6 or Iso2	S	10/100	20/100	20/200	35/200	35/200			
Oc4	S	20/100	35/200	35/200					
Fix	S	20/100	35/200						

*Minimum battery size when using liquid electrolyte (i.e. Delco) Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1 0, 1 9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 69 - Long Beach, CA **Lat 33.82N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/300
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	20/100	N/A
FL(2+1)6 or	B	10/100	10/100	20/100	N/A	20/200	N/A	35/300	
FL(2)5	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	B	10/100	20/100	35/200	N/A	35/300	N/A		
Mo(A)	S	10/100	20/100	20/100	35/200	35/200			
FL4(1)	S	10/100	10/100	20/100	20/100	20/100	35/200	35/200	
FL2.5(1)	S	10/100	20/100	20/100	35/200	35/200			
Iso6 or Iso2	S	10/100	20/100	35/200	35/200	35/200			
Oc4	S	20/100	35/200	35/200					
Fix	S	20/100	35/200						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 70 - Los Angeles, CA **Lat 33.93N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/300
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(3)	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	20/100	N/A
FL(2+1)6 or	B	10/100	10/100	20/100	N/A	20/200	N/A	35/300	
FL(2)5	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/300
Q, FL2(6) or	B	10/100	20/100	35/200	N/A	35/300	N/A		
Mo(A)	S	10/100	20/100	20/100	20/200	35/200			
FL4(1)	S	10/100	10/100	20/100	20/100	20/100	35/200	35/200	
FL2.5(1)	S	10/100	20/100	20/100	35/200	35/200			
Iso6 or Iso2	S	10/100	20/100	35/200	35/200	35/200			
Oc4	S	20/100	35/200	35/200					
Fix	S	20/100	35/200						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 71 - Santa Maria, CA **Lat 34.90N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/300
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	20/100	N/A
FL(2+1)6 or	B	10/100	10/100	20/100	N/A	20/200	N/A	35/300	
FL(2)5	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/200
Q, FL2(6) or	B	10/100	20/100	35/200	N/A	35/300	N/A		
Mo(A)	S	10/100	20/100	20/100	20/200	35/200			
FL4(1)	S	10/100	10/100	20/100	20/100	20/100	35/200	35/200	
FL2.5(1)	S	10/100	20/100	20/100	35/200	35/200			
Iso6 or Iso2	S	10/100	20/100	35/200	35/200	35/200			
Oc4	S	20/100	35/200	35/200					
Fix	S	20/100	35/200						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 72 - San Francisco, CA **Lat 37.62N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL6(.6)	S	10/100	10/100	10/100	N/A	20/100	N/A	20/200	35/200
FL2.5(.3)	B	10/100	20/100	20/100	N/A	20/200	N/A	35/400	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
FL(2+1)6 or	B	10/100	20/100	20/100	N/A	35/200	N/A		
FL(2)5	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
Q, FL2(6) or	B	20/100	35/200	35/200	N/A		N/A		
Mo(A)	S	10/100	20/100	20/200	35/200	35/200			
FL4(1)	S	10/100	20/100	20/100	20/200	35/200			
FL2.5(1)	S	10/100	20/100	35/200	35/200	35/300			
Iso6 or Iso2	S	20/100	35/200	35/200					
Oc4	S	20/100	35/200						
Fix	S	20/100							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 73 - Arcata, CA **Lat 40.98N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	20/200	N/A	35/300	
FL6(.6)	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	
FL2.5(.3)	B	10/100	20/100	20/100	N/A	35/200	N/A		N/A
	S	10/100	10/100	20/100	N/A	20/100	N/A	35/300	N/A
FL(2+1)6 or	B	10/100	20/100	20/200	N/A	35/200	N/A		
FL(2)5	S	10/100	20/100	20/100	N/A	20/200	N/A		
Q, FL2(6) or	B	20/100	35/200	35/400	N/A		N/A		
Mo(A)	S	10/100	20/100	35/200	35/200				
FL4(1)	S	10/100	20/100	20/200	35/200	35/200			
FL2.5(1)	S	20/100	35/200	35/200					
Iso6 or Iso2	S	20/100	35/200						
Oc4	S	20/100							
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 74 - North Bend, OR **Lat 43.42N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/100	N/A	35/200	N/A	35/500	
FL6(.6)	S	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL2.5(.3)	B	10/100	20/100	20/200	N/A	35/200	N/A		N/A
	S	10/100	10/100	20/100	N/A	20/200	N/A	35/300	N/A
FL(2+1)6 or	B	10/100	20/100	35/200	N/A	35/300	N/A		
FL(2)5	S	10/100	20/100	20/100	N/A	35/200	N/A		
Q, FL2(6) or	B	20/100	35/200	35/500	N/A		N/A		
Mo(A)	S	20/100	35/200	35/200					
FL4(1)	S	10/100	20/100	35/200	35/200	35/200			
FL2.5(1)	S	20/100	35/200	35/300					
Iso6 or Iso2	S	20/100	35/200						
Oc4	S	35/200							
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 75 - Astoria, OR **Lat 46.15N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/200	N/A	35/200	N/A		
FL6(.6)	S	10/100	20/100	20/100	N/A	35/200	N/A		
FL2.5(.3)	B	20/100	20/200	35/200	N/A	35/300	N/A		N/A
	S	10/100	20/100	20/200	N/A	35/200	N/A		N/A
FL(2+1)6 or	B	20/100	35/200	35/200	N/A	35/500	N/A		
FL(2)5	S	10/100	20/100	35/200	N/A	35/200	N/A		
Q, FL2(6) or	B	20/200	35/400		N/A		N/A		
Mo(A)	S	20/100	35/200						
FL4(1)	S	20/100	35/200	35/200					
FL2.5(1)	S	20/100	35/300						
Iso6 or Iso2	S	20/200							
Oc4	S	35/200							
Fix	S								

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 76 - Portland, OR **Lat 45.60N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	20/200	N/A	35/200	N/A		
FL6(.6)	S	10/100	20/100	20/100	N/A	35/200	N/A		
FL2.5(.3)	B	20/100	20/200	35/200	N/A	35/300	N/A		N/A
	S	10/100	20/100	20/200	N/A	35/200	N/A		N/A
FL(2+1)6 or	B	20/100	35/200	35/200	N/A	35/500	N/A		
FL(2)5	S	10/100	20/100	35/200	N/A		N/A		
Q, FL2(6) or	B	20/200	35/400		N/A		N/A		
Mo(A)	S	20/100	35/200						
FL4(1)	S	20/100	35/200	35/200					
FL2.5(1)	S	20/200	35/300						
Iso6 or Iso2	S	35/200							
Oc4	S	35/200							
Fix	S								

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns

SOLAR SIZING TABLE - 77 - Pendleton, OR **Lat 45.68N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	20/100	35/200	N/A	35/200	N/A		
FL6(.6)	S	10/100	10/100	20/100	N/A	20/200	N/A	35/200	
FL2.5(.3)	B	20/100	20/100	20/200	N/A	35/200	N/A		N/A
	S	10/100	20/100	20/100	N/A	35/200	N/A		N/A
FL(2+1)6 or	B	20/100	35/200	35/200	N/A	35/400	N/A		
FL(2)5	S	10/100	20/200	35/200	N/A		N/A		
Q, FL2(6) or	B	20/100	35/300		N/A		N/A		
Mo(A)	S	20/100	35/200	35/300					
FL4(1)	S	10/100	20/200	35/200	35/200				
FL2.5(1)	S	20/100	35/200						
Iso6 or Iso2	S	20/100	35/300						
Oc4	S	35/200							
Fix	S	35/200							

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 78 - Quillayute, WA **Lat 47.95N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	20/100	20/200	35/200	N/A	35/300	N/A		
FL6(6)	S	10/100	20/100	20/200	35/200		N/A		
FL2.5(.3)	B	20/100	20/200	35/200	N/A	35/400	N/A		N/A
	S	10/100	20/100	20/200	N/A	35/200	N/A		N/A
FL(2+1)6 or	B	20/100	20/200	35/300	N/A		N/A		
FL(2)5	S	20/100	20/200	35/200	N/A		N/A		
Q, FL2(6) or	B	35/200	35/500		N/A		N/A		
Mo(A)	S	20/100	35/300						
FL4(1)	S	10/100	35/200	35/300					
FL2.5(1)	S	20/200							
Iso6 or Iso2	S	35/200							
Oc4	S	35/300							
Fix	S								

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1 9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 79 - Seattle, WA **Lat 47.45N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	60°	Lamp Size**							
Flasher Rhythm		**.25a**	**.55a**	**.77a**	**1.0a**	**1.15a**	**1.9a**	**2.03a**	**3.0/3.05a**
FL4(.4) or	**B**	20/100	20/200	35/200	N/A	35/300	N/A		
FL6(.6)	**S**	10/100	20/100	20/100	N/A	35/200	N/A		
FL2.5(.3)	**B**	20/100	20/200	35/200	N/A	35/400	N/A		N/A
	S	10/100	20/100	20/200	N/A	35/200	N/A		N/A
FL(2+1)6 or	**B**	20/100	35/200	35/300	N/A		N/A		
FL(2)5	**S**	20/100	20/200	35/200	N/A		N/A		
Q, FL2(6) or	**B**	35/200	35/500		N/A		N/A		
Mo(A)	**S**	20/100	35/300						
FL4(1)	**S**	10/100	35/200	35/300					
FL2.5(1)	**S**	20/200							
Iso6 or Iso2	**S**	35/200							
Oc4	**S**	35/300							
Fix	**S**								

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 80 - Annette, AK **Lat 55.03N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	75°	Lamp Size**							
Flasher Rhythm		**.25a**	**.55a**	**.77a**	**1.0a**	**1.15a**	**1.9a**	**2.03a**	**3.0/3.05a**
FL4(.4) or	**B**	20/100	35/200	35/300	N/A		N/A		
FL6(.6)	**S**	20/100	20/200	35/200	N/A	35/300	N/A		
FL2.5(.3)	**B**	20/200	35/300	35/400	N/A		N/A		N/A
	S	20/100	20/200	35/200	N/A		N/A		N/A
FL(2+1)6 or	**B**	20/200	35/400		N/A		N/A		
FL(2)5	**S**	20/100	35/200	35/300	N/A		N/A		
Q, FL2(6) or	**B**	35/300			N/A		N/A		
Mo(A)	**S**	35/200							
FL4(1)	**S**	20/200	35/300						
FL2.5(1)	**S**	35/200							
Iso6 or Iso2	**S**	35/300							
Oc4	**S**								
Fix	**S**								

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 81 - Yakutat, AK **Lat 59.52N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	75°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	20/200	35/300	35/500	N/A		N/A		
FL6(.6)	S	20/100	35/200	35/200	N/A		N/A		
FL2.5(.3)	B	35/200	35/400		N/A		N/A		N/A
	S	20/100	35/200	35/300	N/A		N/A		N/A
FL(2+1)6 or	B	35/200	35/500		N/A		N/A		
FL(2)5	S	20/200	35/300		N/A		N/A		
Q, FL2(6) or	B	35/400			N/A		N/A		
Mo(A)	S	35/200							
FL4(1)	S	35/200							
FL2.5(1)	S	35/300							
Iso6 or Iso2	S								
Oc4	S								
Fix	S								

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 82 - Anchorage, AK **Lat 61.17N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	75°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	35/200	35/400	35/500	N/A		N/A		
FL6(.6)	S	20/100	35/200	35/300	N/A		N/A		
FL2.5(.3)	B	35/200	35/500		N/A		N/A		N/A
	S	20/100	35/200		N/A		N/A		N/A
FL(2+1)6 or	B	35/300			N/A		N/A		
FL(2)5	S	20/200	35/300		N/A		N/A		
Q, FL2(6) or	B	35/500			N/A		N/A		
Mo(A)	S	35/200							
FL4(1)	S	35/200							
FL2.5(1)	S	35/300							
Iso6 or Iso2	S	35/200							
Oc4	S								
Fix	S								

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 83 - Kodiak, AK **Lat 57.75N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°	Lamp Size**							
S-Structure	75°								
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	20/200	35/300	35/400	N/A		N/A		
FL6(.6)	S	10/100	20/100	35/200	N/A	35/200	N/A		
FL2.5(.3)	B	20/200	35/300	35/500	N/A		N/A		N/A
	S	20/100	20/200	35/200	N/A		N/A		N/A
FL(2+1)6 or	B	35/200	35/400		N/A		N/A		
FL(2)5	S	20/100	35/200	35/300	N/A		N/A		
Q, FL2(6) or	B	35/400			N/A		N/A		
Mo(A)	S	20/200							
FL4(1)	S	20/200	35/300						
FL2.5(1)	S	35/200							
Iso6 or Iso2	S	35/200							
Oc4	S								
Fix	S								

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 84 - Cold Bay, AK **Lat 55.20N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°	Lamp Size**							
S-Structure	75°								
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	20/100	35/200	35/300	N/A		N/A		
FL6(.6)	S	20/100	20/100	35/200	N/A	35/200	N/A		
FL2.5(.3)	B	20/200	35/300	35/400	N/A		N/A		N/A
	S	20/100	20/200	35/200	N/A		N/A		N/A
FL(2+1)6 or	B	35/200	35/400		N/A		N/A		
FL(2)5	S	20/100	35/200	35/300	N/A		N/A		
Q, FL2(6) or	B	35/300			N/A		N/A		
Mo(A)	S	20/200							
FL4(1)	S	20/200	35/300						
FL2.5(1)	S	35/200							
Iso6 or Iso2	S	35/200							
Oc4	S								
Fix	S								

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 85 - King Salmon, AK **Lat 58.68N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	75°	Lamp Size**							
Flasher Rhythm		**.25a**	**.55a**	**.77a**	**1.0a**	**1.15a**	**1.9a**	**2.03a**	**3.0/3.05a**
FL4(4) or	**B**	20/200	35/300	35/400	N/A		N/A		
FL6(.6)	**S**	10/100	20/100	35/200	N/A	35/200	N/A		
FL2.5(.3)	**B**	20/200	35/400	35/500	N/A		N/A		N/A
	S	20/100	20/200	35/200	N/A		N/A		N/A
FL(2+1)6 or	**B**	35/200	35/400		N/A		N/A		
FL(2)5	**S**	20/100	35/200	35/300	N/A		N/A		
Q, FL2(6) or	**B**	35/400			N/A		N/A		
Mo(A)	**S**	20/200							
FL4(1)	**S**	20/100	35/300						
FL2.5(1)	**S**	35/200							
Iso6 or Iso2	**S**	35/200							
Oc4	**S**								
Fix	**S**								

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 86 - Bethel, AK **Lat 60.78N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	75°	Lamp Size**							
Flasher Rhythm		**.25a**	**.55a**	**.77a**	**1.0a**	**1.15a**	**1.9a**	**2.03a**	**3.0/3.05a**
FL4(.4) or	**B**	35/200	35/400	35/500	N/A		N/A		
FL6(.6)	**S**	20/100	20/200	35/200	N/A		N/A		
FL2.5(.3)	**B**	35/200	35/500		N/A		N/A		N/A
	S	20/100	35/200	35/200	N/A		N/A		N/A
FL(2+1)6 or	**B**	35/300			N/A		N/A		
FL(2)5	**S**	20/100	35/200		N/A		N/A		
Q, FL2(6) or	**B**	35/500			N/A		N/A		
Mo(A)	**S**	35/200							
FL4(1)	**S**	20/200							
FL2.5(1)	**S**	35/200							
Iso6 or Iso2	**S**	35/300							
Oc4	**S**								
Fix	**S**								

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 87 - Nome, AK **Lat 64.50N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°	Lamp Size**							
S-Structure	75°								
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	35/300	35/500		N/A		N/A		
FL6(.6)	S	20/200	35/200		N/A		N/A		
FL2.5(.3)	B	35/300			N/A		N/A		N/A
	S	20/200	35/300		N/A		N/A		N/A
FL(2+1)6 or	B	35/400			N/A		N/A		
FL(2)5	S	35/200			N/A		N/A		
Q, FL2(6) or	B				N/A		N/A		
Mo(A)	S	35/300							
FL4(1)	S	35/200							
FL2.5(1)	S								
Iso6 or Iso2	S								
Oc4	S								
Fix	S								

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 88 - Hilo, HI **Lat 19.72N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°	Lamp Size**							
S-Structure	30°								
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(.3)	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	20/100	N/A	20/100	N/A
FL(2+1)6 or	B	10/100	10/100	20/100	N/A	20/100	N/A	35/200	
FL(2)5	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/300
Q, FL2(6) or	B	10/100	20/100	20/100	N/A	35/200	N/A		
Mo(A)	S	10/100	20/100	20/100	20/200	35/200			
FL4(1)	S	10/100	10/100	20/100	20/100	20/100	35/200	35/200	
FL2.5(1)	S	10/100	20/100	20/100	35/200	35/200			
Iso6 or Iso2	S	10/100	20/100	35/200	35/200	35/200			
Oc4	S	20/100	35/200	35/200					
Fix	S	20/100	35/200						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 89 - Kahului, HI **Lat 20.90N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	30°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	20/100
FL2.5(3)	B	10/100	10/100	10/100	N/A	20/100	N/A	20/100	N/A
	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	N/A
FL(2+1)6 or	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/400
FL(2)5	S	10/100	10/100	10/100	N/A	20/100	N/A	20/100	35/200
Q, FL2(6) or	B	10/100	20/100	20/100	N/A	35/200	N/A		
Mo(A)	S	10/100	10/100	20/100	20/100	20/100	35/200	35/300	
FL4(1)	S	10/100	10/100	10/100	20/100	20/100	35/200	35/200	
FL2.5(1)	S	10/100	20/100	20/100	20/100	35/200			
Iso6 or Iso2	S	10/100	20/100	20/100	35/200	35/200			
Oc4	S	10/100	20/100	35/200	35/200				
Fix	S	20/100	35/200	35/200					

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 90 - Honolulu, HI **Lat 21.33N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	30°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	20/100
FL2.5(.3)	B	10/100	10/100	10/100	N/A	20/100	N/A	20/200	N/A
	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	N/A
FL(2+1)6 or	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/500
FL(2)5	S	10/100	10/100	10/100	N/A	20/100	N/A	20/100	35/200
Q, FL2(6) or	B	10/100	20/100	20/100	N/A	35/200	N/A		
Mo(A)	S	10/100	10/100	20/100	20/100	20/200	35/200		
FL4(1)	S	10/100	10/100	10/100	20/100	20/100	35/200	35/200	
FL2.5(1)	S	10/100	20/100	20/100	20/200	35/200			
Iso6 or Iso2	S	10/100	20/100	20/100	35/200	35/200			
Oc4	S	10/100	20/100	35/200	35/200				
Fix	S	20/100	35/200	35/200					

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 91 - Lihue, HI **Lat 21.98N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	30°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL2.5(3)	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	N/A
	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	N/A
FL(2+1)6 or	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/500
FL(2)5	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/200
Q, FL2(6) or	B	10/100	20/100	20/100	N/A	35/200	N/A		
Mo(A)	S	10/100	20/100	20/100	20/100	35/200			
FL4(1)	S	10/100	10/100	20/100	20/100	20/100	35/200	35/200	
FL2.5(1)	S	10/100	20/100	20/100	35/200	35/200			
Iso6 or Iso2	S	10/100	20/100	35/200	35/200	35/200			
Oc4	S	20/100	35/200	35/200					
Fix	S	20/100	35/200						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte) or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 watt panel, 200 AH for 20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lanterns.

SOLAR SIZING TABLE - 92 - Guam **Lat 13.55N**

Tilt Angle		Panel Size (watts)/Battery Size (amp-hours)*							
B-Buoy	0°								
S-Structure	30°	Lamp Size**							
Flasher Rhythm		.25a	.55a	.77a	1.0a	1.15a	1.9a	2.03a	3.0/3.05a
FL4(.4) or	B	10/100	10/100	10/100	N/A	10/100	N/A	20/100	35/200
FL6(.6)	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	20/100
FL2.5(.3)	B	10/100	10/100	10/100	N/A	10/100	N/A	20/100	N/A
	S	10/100	10/100	10/100	N/A	10/100	N/A	20/100	N/A
FL(2+1)6 or	B	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/500
FL(2)5	S	10/100	10/100	10/100	N/A	20/100	N/A	35/200	35/200
Q, FL2(6) or	B	10/100	20/100	20/100	N/A	35/200	N/A		
Mo(A)	S	10/100	10/100	20/100	20/100	35/200	35/200		
FL4(1)	S	10/100	10/100	20/100	20/100	20/100	35/200	35/200	
FL2.5(1)	S	10/100	20/100	20/100	35/200	35/200			
Iso6 or Iso2	S	10/100	20/100	20/100	35/200	35/200			
Oc4	S	20/100	35/200	35/200	35/200				
Fix	S	20/100	35/200						

*Minimum battery size when using liquid electrolyte (i.e. Delco). Minimum battery size for absorbed electrolyte (Sunlyte or gelled (i.e. Deka, Sonnenschein, etc.) is 100 AH for 10 w
20 watt and 300 AH for 35 watt solar panels.

**1.0, 1.9 and 3.0 amp lamps shall only be used in FA-240 and RL-14 range lant

Appendix I - Sample Calculations

Aid Name	**Buoy - Minor Aid**		
Latitude of Aid	39.00	(deg)	
Panel Tilt	0	(deg)	
Ref Site #	12	BALTIMORE	(design radiation)
Latitude Ref Site	39.18	(deg)	
Use Average Rad?	n	(enter "Y" to see results for average radiation)	
Battery Type	wet	(enter "wet", "gel", or "abs")	
Autonomy		(days, default is 10 days)	
Interval Installed	18		
SofC at Install	100	(%)	

Load	Amps?	Duty Cycle (if <100%) (10=10%)	D, N, or DN	# Hours Day/Night Loads Operate (if < 24)	SEASONAL AIDS ON At Start of Interval Number	SEASONAL AIDS OFF At End of Interval Number
155mm,0.77a,FL4	0.894	10	N			
Number of Flashers	1					

Suggested Array Size (for initial computations): 20 watts
Array Size: 20 (watts) **Minimum SofC: 95 %**

Suggested Battery Size for self-regulated system: 100 A-h
Suggested Battery Size for regulated system: 100 A-h
Battery Size: 100 (A-h)

Interval No	Dates	Minimum SofC(%)	Maximum SofC(%)
1	Jan 1-15	95	100
2	Jan 16-31	98	100
3	Feb 1-14	98	100
4	Feb 15-28	98	100
5	Mar 1-15	98	100
6	Mar 16-31	98	100
7	Apr 1-15	98	100
8	Apr 16-30	99	100
9	May 1-15	99	100
10	May 16-31	99	100
11	June 1-15	99	100
12	June 16-30	99	100
13	July 1-15	99	100
14	July 16-31	99	100
15	Aug 1-15	99	100
16	Aug 16-31	99	100
17	Sep 1-15	98	100
18	Sep 16-30	98	100
19	Oct 1-15	98	100
20	Oct 16-31	98	100
21	Nov 1-15	98	100
22	Nov 16-30	98	100
23	Dec 1-15	96	100
24	Dec 16-31	95	98

Minimum SofC: 95 %

Max Daily Load = 1.8 amp-hours

C/50 = 2.0 amps
Max Charge Rate = 1.4 amps

Aid Name	**Day/Night Range**		
Latitude of Aid	39.00	(deg)	
Panel Tilt	60	(deg)	
Ref Site #	12	BALTIMORE	(design radiation)
Latitude Ref Site	39.18	(deg)	
Use Average Rad?	n	(enter "Y" to see results for average radiation)	
Battery Type	wet	(enter "wet", "gel", or "abs")	
Autonomy		(days, default is 10 days)	
Interval Installed	18		
SofC at Install	100	(%)	

Load	Amps?	Duty Cycle (if <100%) (10=10%)	D, N, or DN	# Hours Day/Night Loads Operate (if < 24)	SEASONAL AIDS ON At Start of Interval Number	SEASONAL AIDS OFF At End of Interval Number
RL14.0.55a,Iso2	0.578	50	N			
RL14.50w,Iso2	4.730	50	D			
RPB	0.190	100	D			
RSB	0.170	100	D			
Number of Flashers	1					

Suggested Array Size (for initial computations): 200 watts
Array Size: 200 (watts) **Minimum SofC: 91 %**

Suggested Battery Size for self-regulated system: 780 A-h
Suggested Battery Size for regulated system: 585 A-h
Battery Size: 585 (A-h)

Interval No	Dates	Minimum SofC(%)	Maximum SofC(%)
1	Jan 1-15	91	100
2	Jan 16-31	94	100
3	Feb 1-14	94	100
4	Feb 15-28	93	100
5	Mar 1-15	93	100
6	Mar 16-31	93	100
7	Apr 1-15	93	100
8	Apr 16-30	93	100
9	May 1-15	93	100
10	May 16-31	93	100
11	June 1-15	93	100
12	June 16-30	92	100
13	July 1-15	93	100
14	July 16-31	93	100
15	Aug 1-15	93	100
16	Aug 16-31	93	100
17	Sep 1-15	93	100
18	Sep 16-30	94	100
19	Oct 1-15	94	100
20	Oct 16-31	94	100
21	Nov 1-15	94	100
22	Nov 16-30	94	100
23	Dec 1-15	92	100
24	Dec 16-31	91	97

Minimum SofC: 91 %

Max Daily Load = 43.7 amp-hours

C/50 = 11.7 amps
Max Charge Rate = 11.8 amps

Aid Name	Lighthouse - Major Aid		
Latitude of Aid	42.00	(deg)	
Panel Tilt	60	(deg)	
Ref Site #	2	BOSTON	(design radiation)
Latitude Ref Site	42.37	(deg)	
Use Average Rad?	n	(enter "Y" to see results for average radiation)	
Battery Type	wet	(enter "wet", "gel", or "abs")	
Autonomy		(days, default is 10 days)	
Interval Installed	18		
SofC at install	100	(%)	

Load	Amps?	Duty Cycle (if <100%) (10=10%)	D, N, or DN	# Hours Day/Night Loads Operate (if < 24)	SEASONAL AIDS ON At Start of Interval Number:	SEASONAL AIDS OFF At End of Interval Number.
VRB-25, 50w	4.170	100	N			
VRB-25 Motor	0.100	100	DN			
FA-232	1.800	10	DN	8		
SDB, 2 SACIIs	0.030	100	DN			
VM-100	0.800	100	DN			
VM-100 - Heaters	1.000	75	DN		23	4
LEACMS/Radio	0.500	100	DN			
Charge Controller	0.010	100	DN			
Number of Flashers	0					

Suggested Array Size (for initial computations) 720 watts
Array Size. 720 (watts) **Minimum SofC: 71 %**

Suggested Battery Size for self-regulated system 2915 A-h
Suggested Battery Size for regulated system 1560 A-h
Battery Size 1560 (A-h)

Interval No	Dates	Minimum SofC(%)	Maximum SofC(%)
1	Jan 1-15	71	100
2	Jan 16-31	92	100
3	Feb 1-14	92	100
4	Feb 15-28	92	100
5	Mar 1-15	94	100
6	Mar 16-31	94	100
7	Apr 1-15	94	100
8	Apr 16-30	95	100
9	May 1-15	95	100
10	May 16-31	95	100
11	June 1-15	95	100
12	June 16-30	95	100
13	July 1-15	95	100
14	July 16-31	95	100
15	Aug 1-15	95	100
16	Aug 16-31	95	100
17	Sep 1-15	95	100
18	Sep 16-30	94	100
19	Oct 1-15	94	100
20	Oct 16-31	94	100
21	Nov 1-15	94	100
22	Nov 16-30	93	100
23	Dec 1-15	80	100
24	Dec 16-31	72	88

Minimum SofC: 71 %

Max Daily Load = 116.1 amp-hours

C/50 = 31.2 amps
Max Charge Rate = 50.0 amps

Aid Name	Lighthouse - Minor Aid		
Latitude of Aid	36.90	(deg)	
Panel Tilt	60	(deg)	
Ref Site #	14	NORFOLK	(design radiation)
Latitude Ref Site	36.9	(deg)	
Use Average Rad?	n	(enter "Y" to see results for average radiation)	
Battery Type	wet	(enter "wet", "gel", or "abs")	
Autonomy		(days, default is 10 days)	
Interval Installed	18		
SofC at install	100	(%)	

Load	Amps?	Duty Cycle (if <100%) (10=10%)	D, N, or DN	# Hours Day/Night Loads Operate (if < 24)	SEASONAL AIDS ON At Start of Interval Number	SEASONAL AIDS OFF At End of Interval Number
VRB-25, 1.9a	1.900	100	N			
VRB-25 Motor	0.100	100	DN			
FA-232	1.800	13.3	DN			
SDB	0.025	100	DN			
Number of Flashers	1					

Suggested Array Size (for initial computations) 200 watts
Array Size 200 (watts) **Minimum SofC: 88 %**

Suggested Battery Size for self-regulated system. 780 A-h
Suggested Battery Size for regulated system 585 A-h
Battery Size 780 (A-h)

Interval No	Dates	Minimum SofC(%)	Maximum SofC(%)
1	Jan 1-15	88	98
2	Jan 16-31	93	100
3	Feb 1-14	95	100
4	Feb 15-28	95	100
5	Mar 1-15	96	100
6	Mar 16-31	96	100
7	Apr 1-15	96	100
8	Apr 16-30	96	100
9	May 1-15	96	100
10	May 16-31	96	100
11	June 1-15	96	100
12	June 16-30	97	100
13	July 1-15	96	100
14	July 16-31	96	100
15	Aug 1-15	96	100
16	Aug 16-31	96	100
17	Sep 1-15	96	100
18	Sep 16-30	96	100
19	Oct 1-15	96	100
20	Oct 16-31	95	100
21	Nov 1-15	95	100
22	Nov 16-30	95	100
23	Dec 1-15	91	100
24	Dec 16-31	88	96

Minimum SofC: 88 %

Max Daily Load = 36.5 amp-hours

C/50 = 15.6 amps
Max Charge Rate = 14.1 amps

Appendix II - Addendum for Solar Vertical Program

The solar vertical program is used exclusively for buoys with single, dual or quad mounted solar panels. **The program will only evaluate flat or vertically mounted solar panels.** This program does not have an input for tilt angles and evaluation of the dual panel mount (15 degree tilt), tripod mount (60 degrees) and any fixed structure requires use of the solar design program.

Data entry is the same as the solar design program with the exception of the panel tilt (no entry) and array size. The program has three suggested array sizes: Horizontal Panel, 4 Vertical Panels and 2 Vertical Panels. The program suggests panel sizes for all three combinations. If 40+ is suggested, then that combination alone may not satisfy the design constraints of 65-70 percent minimum state of charge. If 40+ exists for all suggestions, then combinations of two suggestions (horizontal and vertical panels), doubling of the quad array (8 panels; enter 80 watts) or inclusion of a Wave Turbine Generator (WTG) may provide satisfactory results.

Once the array type is chosen, enter solar panel wattage into the appropriate block. If more than one block is filled, then the buoy must be outfitted with both combinations (i.e., one horizontal panel and 4 quad mounted panels).

The contribution by a WTG can be approximated by entering the WTG output as **0.5** amp "additional input amperage" in block M48 of the spreadsheet. This contribution of 12 amp-hours per day is realistic for sites with continuous wave action. WTGs should only be used as a last resort to adding additional solar panels as they are costly and maintenance intensive.

This program can not evaluate installation of solar panels in radar reflectors of buoys. Shadowing of the panel(s) by the lantern ring and adjacent walls of the reflector will reduce output of the array. Installation of solar panels in this area is not recommended.

Solar Vertical Program
Sample Calculation

Aid Name	Exposed Location Buoy	
Latitude of Aid		(deg, OPTIONAL)
Ref Site #	9	ATLANTIC CITY (design radiation)
Latitude Ref Site	39 45	(deg)
Use Average Rad?		(enter "Y" to see results for average radiation)
Battery Type	wet	(enter "wet", "gel" or "abs")
Autonomy		(days default is 20 days)
Interval Installed	18	
SofC at Install	100	(%)

Load	Amps?	Duty Cycle (if <100%) (10=10%)	D, N, or DN	# Hours Day/Night Loads Operate (if < 24)	SEASONAL AIDS ON At Start of Interval Number:	OFF At End of Interval Number:
155mm,0.77a,FL2.5	0 916	12	N			
API XFB-005, FL2 5	0 544	100	N			
Racon	0 212	100	DN			
Number of Flashers.	1					

Suggested Panel Size for a **HORIZONTAL PANEL**: 40 + watts
Suggested Panel Size for each of **4 VERTICAL PANELS**: 40 watts
Suggested Panel Size for each of **2 VERTICAL PANELS**: 40 + watts

Selected size of **HORIZONTAL PANEL**: (watts)
Selected size of each of **4 VERTICAL PANELS**: 40 (watts)
Selected size of each of **2 VERTICAL PANELS**: (watts)

Suggested Battery Size. 400 (A-h)
Selected Battery Size 500 (A-h)

Comments.
Exposed Location Buoy with four Siemens 35 watt panels attached to the superstructure.

Interval No	Dates	Minimum SofC(%)	Maximum SofC(%)	Standard Bat Sizes
1	Jan 1-15	71	75	100
2	Jan 16-31	72	77	200
3	Feb 1-14	73	86	300
4	Feb 15-28	83	95	400
5	Mar 1-15	92	100	500
6	Mar 16-31	97	100	600
7	Apr 1-15	97	100	
8	Apr 16-30	97	100	
9	May 1-15	98	100	
10	May 16-31	98	100	
11	June 1-15	98	100	
12	June 16-30	98	100	
13	July 1-15	98	100	
14	July 16-31	98	100	
15	Aug 1-15	98	100	
16	Aug 16-31	97	100	
17	Sep 1-15	97	100	
18	Sep 16-30	97	100	
19	Oct 1-15	97	100	
20	Oct 16-31	97	100	
21	Nov 1-15	94	100	
22	Nov 16-30	91	97	
23	Dec 1-15	82	94	
24	Dec 16-31	72	84	

Minimum SofC: **71 %**

Max Daily Load = **15.1** **amp-hours**

C/50 = 10 0 amps
Max Charge Rate = 5 6 amps

Show "Attachment I I" ?
Additional Input Amperage. (amps continuous)
Additional Input Daily A-H 0 (amp-hours)

Solar Vertical Program
Sample Calculation

Appendix III - Battery Acquisition and Application Data

The following is a list of batteries recommended by Commandant (G-SEC-2) for use in solar powered aids to navigation. Batteries listed here have shown, through manufacturer's literature, testing or field experience, to perform well in our unique environment.

Batteries are categorized as either "qualified" or "conditionally qualified". "Qualified" refers to batteries that have been tested and perform well in the field. "Conditionally qualified" are batteries that are new technology being evaluated, or batteries that have limitations placed on them. New batteries that are conditionally qualified should not be placed in critical aids or in aids at the outskirts of your area of responsibility.

All batteries are 12 volts, 100 ampere-hours (nominal) and intended for use in all solar powered minor aids, unless otherwise specified. Please call the vendors for a current price quote and shipping costs (if applicable).

Delco 2000, Delco S2000

Features: 12 volt, liquid electrolyte, lead calcium grid, maintenance-free, not sealed. Available from the factory in quantities of 54 (Delco 2000) or lesser quantities from local wholesalers (Delco S2000).

Price $63.50 to $68.00.
Price quoted from factory is delivered to destination by truck freight. Price quoted from wholesaler is delivered to destination by Mobile Battery Truck (MBT).

Status: Qualified

Ordering Addresses:

Factory:

Delco Remy
P.O. Box 2439
Anderson, IN 46018
(317) 579-3591

Wholesalers:

Batteries, Inc.
4788 Lake Mirror Place
Forest Park, GA 30050
(404) 361-6260 Attn: Randy Dunn

Delcoline, Inc.,
Automotive Parts and Warehouser and Exporter
4631 Tanglewood Drive

Hyattsville, MD 20781
(301) 864-4455 Attn: Kambiz Majidi

Diesel Service Unit
P.O. Box 3486
Portland, OR 97208
(800) 556-4998 [(800) 452-9179 in OR] Attn: Larry Clay

GNB Sunlyte 12-5000

Features: 12 volt, absorbed electrolyte, lead calcium grid, maintenance free, handle, sealed.

Price: $96.00 plus shipping (must be prepaid).

Status: Conditionally qualified (not recommended in hot climates)

Ordering address: See below.

GNB Absolyte IIP

Features: 2-volt, absorbed electrolyte, lead calcium grid, sealed, maintenance free, used in large lighthouse and range power systems.

Capacities from 340 AH to 5700 AH.

Price: $144.00 - $1585.00 per cell plus shipping (must be prepaid).

Status: Conditionally qualified (not recommended in hot climates)

Ordering address:

GNB Battery Technologies
829 Parkview Blvd.
Lombard, IL 60148-3249
(708) 629-5200 Ask for Government sales

Exide EJ and FHGS series

Features: 2-volt, liquid electrolyte, tubular lead calcium low antimony grid, requires annual watering, not sealed, used in large lighthouse and range power systems. Capacities from 390 AH to 2915 AH.

Price: $307.50 to $1468.50 per cell delivered in 48 states (6 cells must be ordered, and 1.300 specific gravity must be specified).

General Services Administration schedule pending; call for availability.

Status: Qualified (must be used on stable platform)

Ordering address:

Yuasa-Exide, Inc.
9055 Guilford Road
Columbia, MD 21046-1879
(410) 381-8500

Exide HC-31

Features: 12 volt, liquid electrolyte, lead calcium grid, maintenance free, handle, not sealed.

Price: $54.00 plus shipping (must be prepaid).

Status: Conditionally qualified (new vendor)

Ordering address: (note: this is a different division and should not be confused with Yuasa-Exide).

Exide Corporation
817 Manufacturers Drive
Westland, MI 48185
(800) 323-2914

Sonnenschein Dryfit A 600 Solar

Features: 2-volt, gelled electrolyte, lead calcium grid, sealed, maintenance free, used in large lighthouse and range power systems.

Capacities from 360 AH to 3500 AH.

Price: $144.00 - $893.00 per cell plus shipping (must be prepaid).

Status: Conditionally qualified (new vendor in US, established in Europe)

Ordering address:

Exide Corporation - International Gel Product Sales
645 Penn Street
Reading, PA 19601
(610) 378-0500 Peter Grimes

Johnson Controls Dynasty GC12V100B

Features: 12 volt, gelled electrolyte, lead calcium grid, handle, maintenace free, sealed, same as Solar Electric Specialties 12SC90B which is no longer available.

Price: $112.00 to $150.00, depending on quantity, plus shipping (must be prepaid).

Status: Conditionally qualified (new vendor)

Ordering address:

Contact Commandant (G-SEC-2) for nearest distributor

Deka Solar 8G30H

Features: 12 volt, gelled electrolyte, lead calcium grid, maintenance free, handle, sealed.

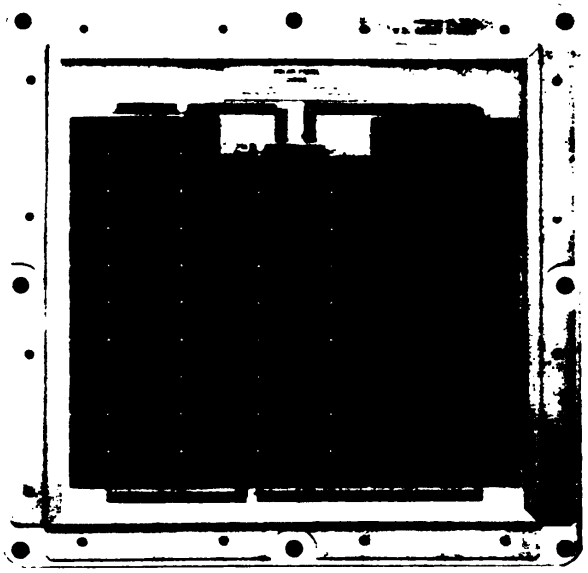
Price: $140.00 plus shipping (must be prepaid).

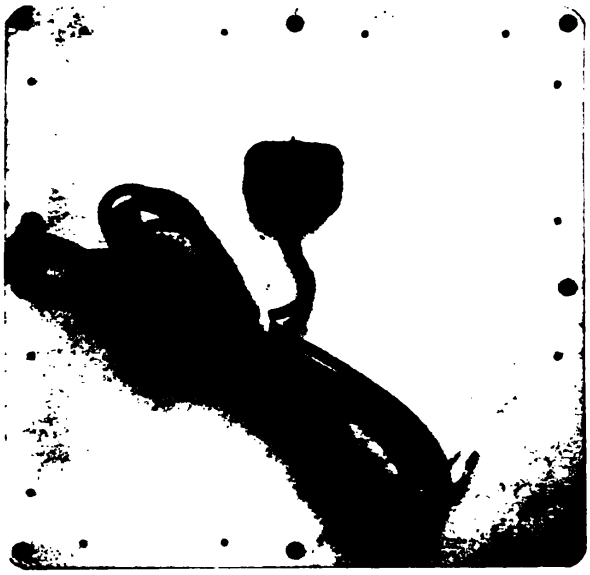
Status: Conditionally qualified (new vendor)

Ordering address:

East Penn Manufacturing Co.
Lyon Station, PA
(215) 682-6361

UNCLASSIFIED MAR-10





SOLAR PHOTOVOLTAIC ARRAY, MAR-10

FUNCTIONAL DESCRIPTION

The photovoltaic array converts sunlight into electricity. The current generated by the photovoltaic array during the day charges 12 volt storage batteries which power the Aid to Navigation at night. The 12 volt DC electrical load consists of a CG-181 flasher and a CG-6P lampchanger.

RELATION TO OTHER EQUIPMENT

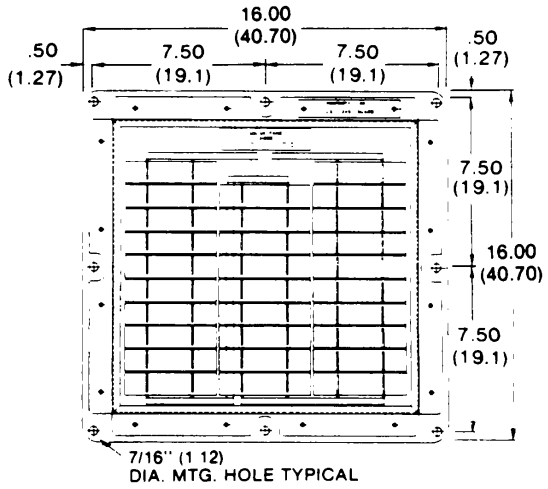
The photovoltaic array and secondary batteries replace primary batteries. Each photovoltaic array is equipped with a blocking diode.

EQUIPMENT REQUIRED BUT NOT SUPPLIED

CG-181 flasher with 12 VDC switching voltage regulator
CG-6P lampchanger
Marine signal lamps of appropriate rating
12 volt secondary batteries

MECHANICAL CHARACTERISTICS

Installation locations
Buoys, Structures
U.S.C.G. support hardware is needed to mount the photovoltaic array to the Aid to Navigation.
Mounting Dimension
16.0 in. x 16.0 in. x 1.4 in.
(40.7 cm x 40.7 cm x 3.6 cm)
12 ft. of factory installed cable supplied

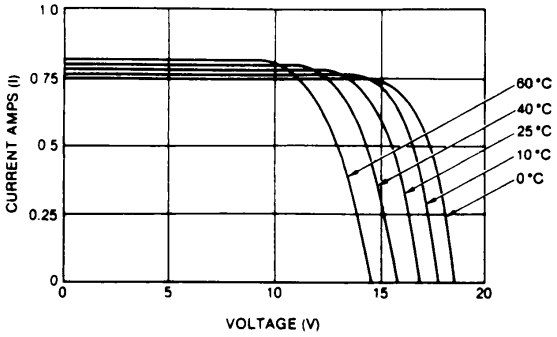


UNCLASSIFIED

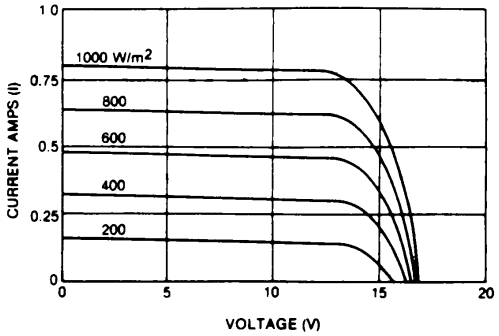
MAR-10

ELECTRICAL CHARACTERISTICS

MAR-10
PERFORMANCE AT
VARIOUS TEMPERATURES
AT AM 1.5 (1 kw/m^2)



MAR-10
PERFORMANCE AT
VARIOUS LIGHT INTENSITIES
AT 25 °C CELL TEMP.



Variance of electrical characteristics with ambient temperature for array

voltage	increases by	71.0 mv/ °C	below 25 °C
	decreases by	71.0 mv/ °C	above 25 °C
current	increases by	0.49 ma/ °C	above 25 °C
	decreases by	0.49 ma/ °C	below 25 °C

Power Specifications	MAR 10* -02 TYPE A	-01 TYPE B
Power (typical ± 10%)	10 Watts	10 Watts
Current (typical @ load)	0.80 Amps	0.78 Amps
Voltage (typical @ load)	13.3 Volts	13.3 Volts
Short Circuit Current (typical)	0.85 Amps	0.82 Amps
Open Circuit Voltage (typical)	16.9 Volts	16.9 Volts

REFERENCE DATA AND LITERATURE

Engineering drawing # 015773
Ocean Engineering Specification G-EOE-401

MANUFACTURER'S DATA

Siemens Solar Industries
4650 Adohr Lane
Camarillo, CA 93012

solar photovoltaic array MAR-10
Contract DTCG36-90-D-00002
NSN No. 5999-01-145-7152

ACTIVE COMPONENT COMPLEMENT

Twenty-nine (29) single crystal silicon solar cells,
1.00 in. x 4.05 in. (2.54 cm x 10.29 cm)

EQUIPMENT SUPPLIED

QUANTITY	NOMENCLATURE	OVERALL DIMENSIONS: INCHES (cm) HEIGHT	WIDTH	DEPTH	VOLUME Cu. ft. (m^3)	WEIGHT POUNDS (Kg)
1	Solar photovoltaic array MAR-10	16.0 (40.7)	16.0 (40.7)	1.4 (3.6)	0.3 (0.01)	5.86 (2.66)

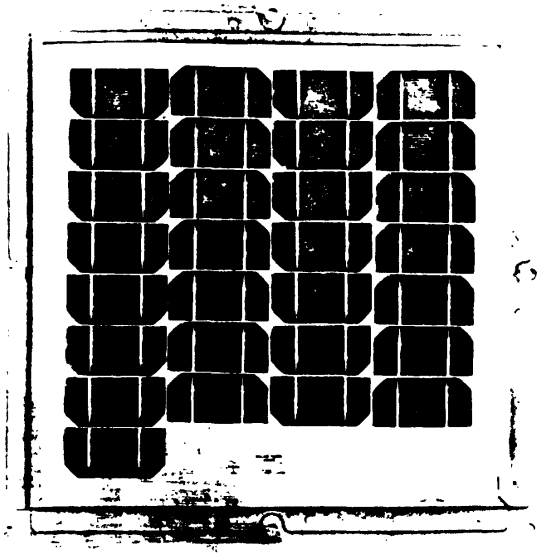
SHIPPING DATA

SHIPPING BOX NO.	CONTENTS	OVERALL DIMENSIONS: INCHES (cm) HEIGHT	WIDTH	DEPTH	VOLUME Cu. ft. (m^3)	WEIGHT POUNDS (Kg)
1	Solar photovoltaic array MAR-10	19 (48.85)	19 (48.85)	2.9 (7.46)	0.8 (0.02)	6.0 (3.58)

*-01 DESIGNATES CIRCUIT MADE WITH END PIECES OF CELLS
-02 DESIGNATES CIRCUIT MADE WITH CENTER PIECES OF CELLS

UNCLASSIFIED

MAR-20



SOLAR PHOTOVOLTAIC ARRAY, MAR-20

FUNCTIONAL DESCRIPTION

The photovoltaic array converts sunlight into electricity. The current generated by the photovoltaic array during the day charges 12 volt storage batteries which power the Aid to Navigation at night. The 12 volt DC electrical load consists of a CG-181 flasher and a CG-6P lampchanger.

RELATION TO OTHER EQUIPMENT

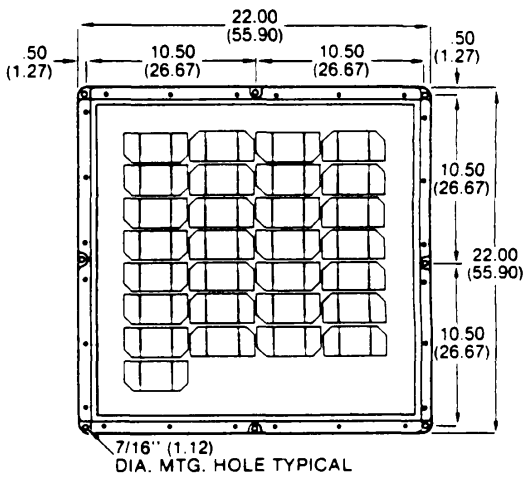
The photovoltaic array and secondary batteries replace primary batteries. Each photovoltaic array is equipped with a blocking diode.

EQUIPMENT REQUIRED BUT NOT SUPPLIED

CG-181 flasher with 12 VDC switching voltage regulator
CG-6P lampchanger
Marine signal lamps of appropriate rating
12 volt secondary batteries

MECHANICAL CHARACTERISTICS

Installation locations
Buoys, Structures
U.S.C.G. support hardware is needed to mount the photovoltaic array to the Aid to Navigation.
Mounting Dimension
22.0 in. x 22.0 in. x 1.4 in.
(55.9 cm x 55.9 cm x 36 cm)
6 ft. of factory installed cable supplied

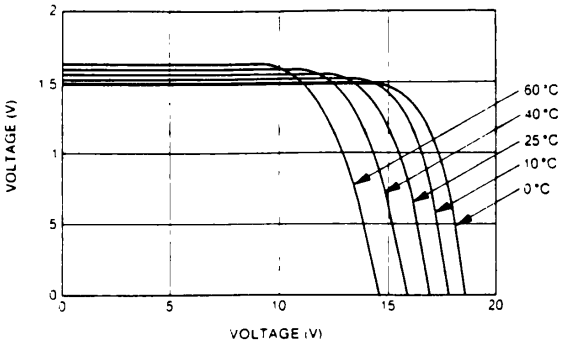


UNCLASSIFIED

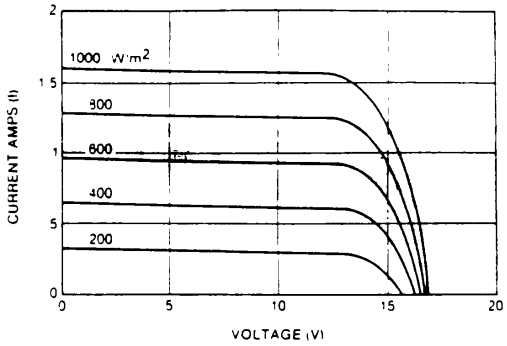
MAR-20

ELECTRICAL CHARACTERISTICS

MAR-20
PERFORMANCE AT
VARIOUS TEMPERATURES
AT AM 1 5 (1 kw/m^2)



MAR-20
PERFORMANCE AT
VARIOUS LIGHT INTENSITIES
AT 25 °C CELL TEMP.



Variance of electrical characteristics with ambient temperature for array

voltage	increases by	79.8 mv/°C	below 25°C
	decreases by	79.8 mv/°C	above 25°C
current	increases by	1.03 ma/°C	above 25°C
	decreases by	1.03 ma/°C	below 25°C

Power Specifications	MAR 35
Power (typical ± 10%)	20 Watts
Current (typical @ load)	1.51 Amps
Voltage (typical @ load)	13.3 Volts
Short Circuit Current (typical)	1.60 Amps
Open Circuit Voltage (typical)	16.9 Volts

REFERENCE DATA AND LITERATURE

Engineering drawing # 015770
Ocean Engineering Specification G-EOE-401

MANUFACTURER'S DATA

ARCO Solar, Inc.
9351 Deering Avenue
Chatsworth, CA 91311

solar photovoltaic array MAR-20
Contract
NSN No. 5999-01-145-7153

ACTIVE COMPONENT COMPLEMENT

Twenty-nine (29) single crystal silicon solar cells, 2.03 in. x 4.05 in. (5.15 cm x 10.29 cm)

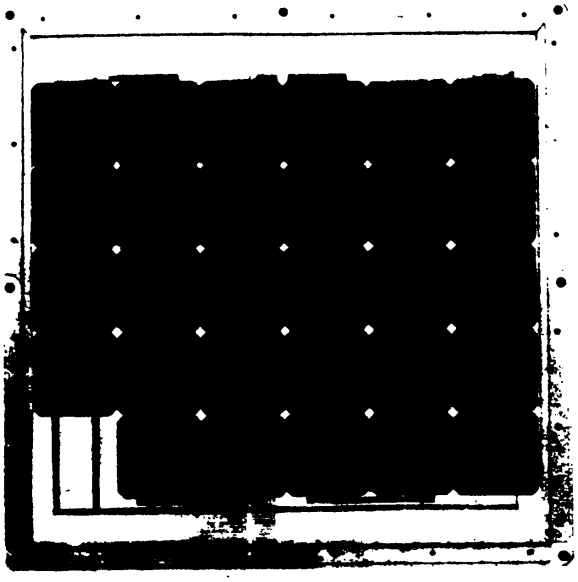
EQUIPMENT SUPPLIED

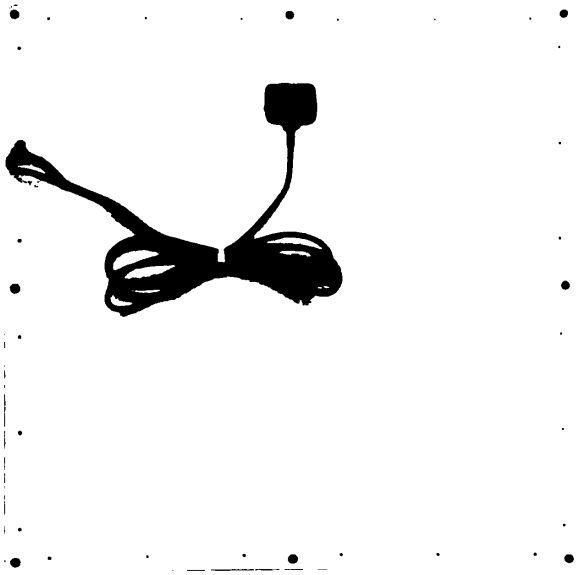
QUANTITY	NOMENCLATURE	OVERALL DIMENSIONS: INCHES (cm) HEIGHT	WIDTH	DEPTH	VOLUME Cu. ft. (m^3)	WEIGHT POUNDS (Kg)
1	Solar photovoltaic array MAR-20	22.0 (55.9)	22.0 (55.9)	1.4 (3.6)	0.5 (0.02)	12.0 (5.44)

SHIPPING DATA

SHIPPING BOX NO.	CONTENTS	OVERALL DIMENSIONS: INCHES (cm) HEIGHT	WIDTH	DEPTH	VOLUME Cu. ft. (m^3)	WEIGHT POUNDS (Kg)
1	Solar photovoltaic array MAR-20	23.5 (76.52)	23.5 (76.52)	4.1 (10.48)	1.32 (0.04)	16 0 (7.24)

UNCLASSIFIED MAR-35





SOLAR PHOTOVOLTAIC ARRAY, MAR-35

FUNCTIONAL DESCRIPTION

The photovoltaic array converts sunlight into electricity. The current generated by the photovoltaic array during the day charges 12 volt storage batteries which power the Aid to Navigation at night. The 12 volt DC electrical load consists of a CG-181 flasher and a CG-6P lampchanger.

RELATION TO OTHER EQUIPMENT

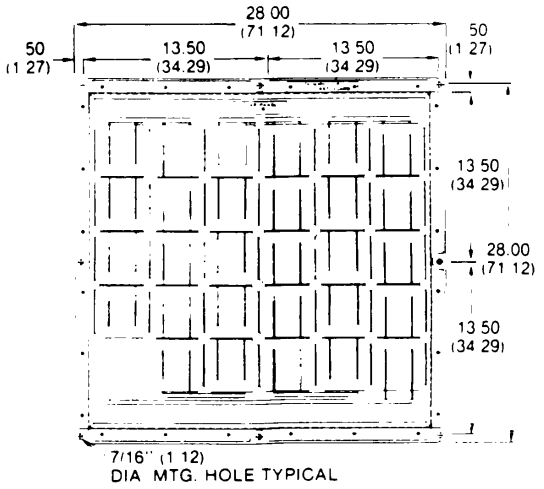
The photovoltaic array and secondary batteries replace primary batteries. Each photovoltaic array is equipped with a blocking diode.

EQUIPMENT REQUIRED BUT NOT SUPPLIED

CG-181 flasher with 12 VDC switching voltage regulator
CG-6P lampchanger
Marine signal lamps of appropriate rating
12 volt secondary batteries

MECHANICAL CHARACTERISTICS

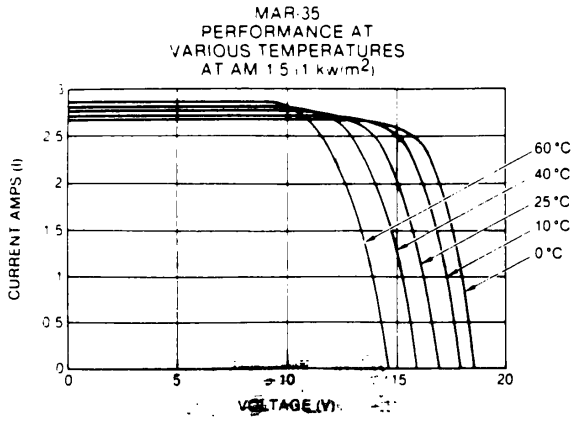
Installation locations
Buoys, Structures
U.S.C.G. support hardware is needed to mount the photovoltaic array to the Aid to Navigation.
Mounting Dimension
28.0 in. x 28.0 in. x 1.4 in.
(71.12 cm x 71.12 cm x 36 cm)
12 ft. of factory installed cable supplied

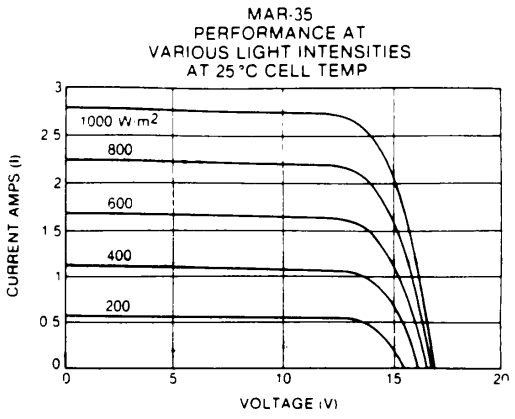


UNCLASSIFIED

MAR-35

ELECTRICAL CHARACTERISTICS





Variance of electrical characteristics with ambient temperature for array

voltage	increases by	71.0 mv/ °C	below 25 °C
	decreases by	71.0 mv/ °C	above 25 °C
current	increases by	1.88 ma/ °C	above 25 °C
	decreases by	1.88 ma/ °C	below 25 °C

Power Specifications	MAR 35
Power (typical ± 10%)	35 Watts
Current (typical @ load)	2.64 Amps
Voltage (typical @ load)	13.3 Volts
Short Circuit Current (typical)	2.80 Amps
Open Circuit Voltage (typical)	16.9 Volts

REFERENCE DATA AND LITERATURE

Engineering drawing #015774
Ocean Engineering Specification G-EOE-401

MANUFACTURER'S DATA

Siemens Solar Industries
4650 Adohr Lane
Camarillo, CA 93012

solar photovoltaic array MAR-35
Contract DTCG36-90-D-00002
NSN No. 5999-01-148-7879

ACTIVE COMPONENT COMPLEMENT

Twenty-nine (29) single crystal silicon solar cells, 4.05 in. x 4.05 in. (10.29 cm x 10.29 cm)

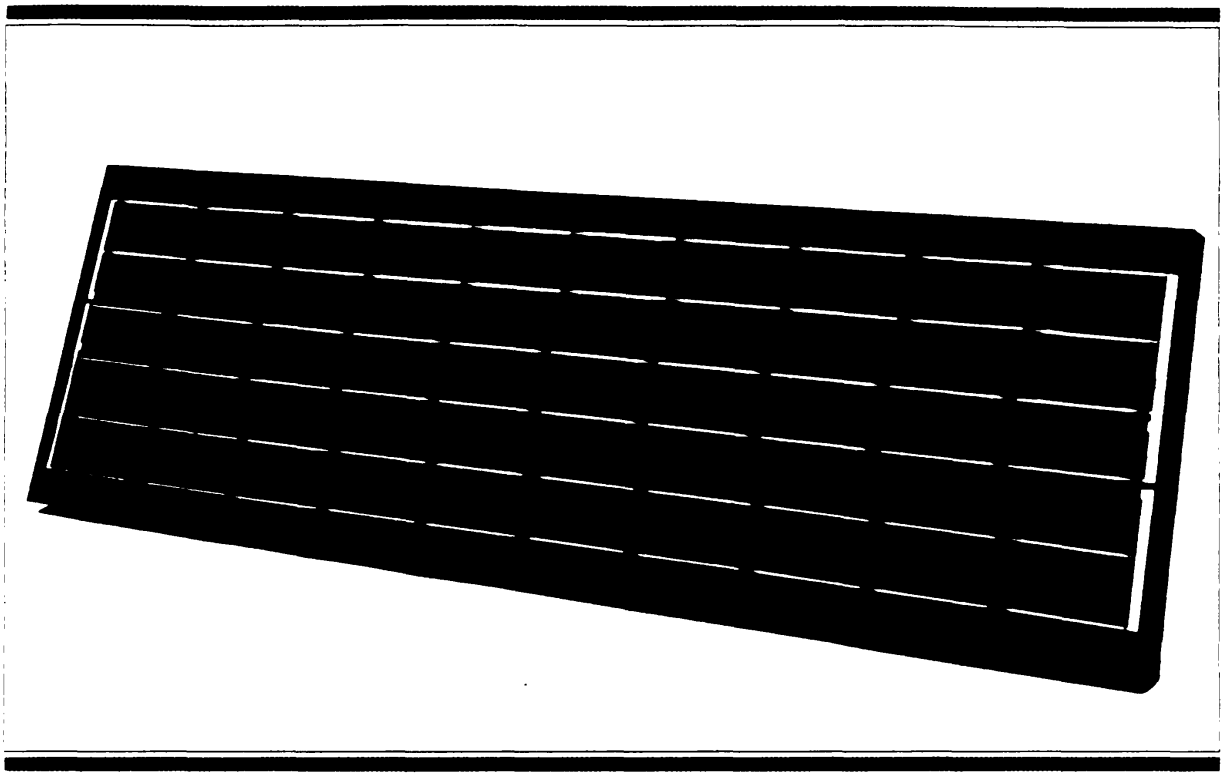
EQUIPMENT SUPPLIED

QUANTITY	NOMENCLATURE	OVERALL DIMENSIONS: INCHES (cm) HEIGHT	WIDTH	DEPTH	VOLUME Cu. ft. (m^3)	WEIGHT POUNDS (Kg)
1	Solar photovoltaic array MAR-35	28.0 (71.12)	28.0 (71.12)	1.4 (3.60)	0.9 (0.13)	17.9 (8.12)

SHIPPING DATA

SHIPPING BOX NO.	CONTENTS	OVERALL DIMENSIONS: INCHES (cm) HEIGHT	WIDTH	DEPTH	VOLUME Cu. ft. (m^3)	WEIGHT POUNDS (Kg)
1	Solar photovoltaic array MAR-35	31.0 (79.71)	31.0 (79.71)	2.9 (7.46)	1.9 (0.27)	21.0 (12.55)

M65 Self regulating solar electric module



RATED POWER 43 WATTS. With 30 cells in series, the high efficiency Siemens M65 is a 43 watt, self regulating solar electric module. Self regulation eliminates the need for seperate charge control devices, resulting in a simple, reliable and economical power generating system. The M65 module regulates its electrical output to the needs of the battery. As the battery approaches full charge, it decreases its typical current charging rate of nearly 3 amps to less than 1/2 amp. Utilizing the highest standard of construction, the M65 module is able to withstand some of the harshest environments in the world and continue to perform efficiently.

Siemens solar electric modules are tested to meet or exceed industry standards, and even more rigorous Siemens quality and performance requirements.

10 YEAR WARRANTY. The Siemens M65 solar electric module carries a 10-year limited warranty on power output and is listed by Underwriters Laboratories (UL), an independent, not for profit organization, testing for public safety.

Siemens solar electric module features:

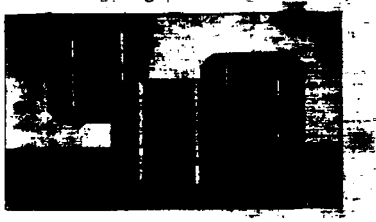
Silent operation
Sunlight as fuel
High power density
Easy installation
Rugged, durable construction
Simple, reliable operation
East to expand systems
Low maintenance
No moving parts to wear out
No environmental pollutants

M65 Self regulating solar electric module

FEATURES

Large, high efficiency single crystal solar cells provide the highest light to energy conversion efficiency available from Siemens.

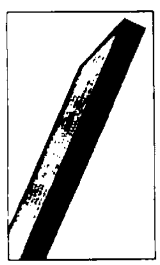
Cells are textured and have an anti-reflection coating.



Multiple redundant contacts provide a high degree of fault tolerance and circuit reliability.

Cells within a module are electrically-matched for increased efficiency.

Circuit is laminated between layers of ethylene vinyl acetate (EVA) for moisture resistance, UV stability and electrical isolation.

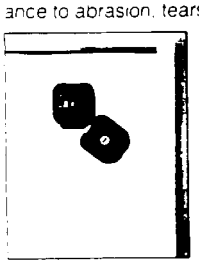


Low iron tempered glass front for strength and superior light transmission.

Rugged anodized aluminum frame is designed for exceptional strength.

Side rails with multiple mounting holes for easy installation.

Tough multi-layered polymer backsheet is used for environmental protection, resistance to abrasion, tears and punctures.



Two junction covers with lids are designed for easy field wiring, safety and environmental protection.

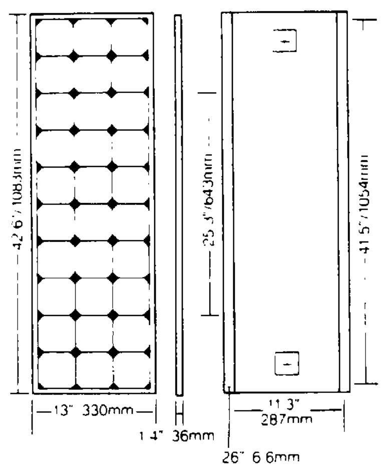
Wired-in bypass diodes reduce potential loss of power from partial array shading.

SPECIFICATIONS

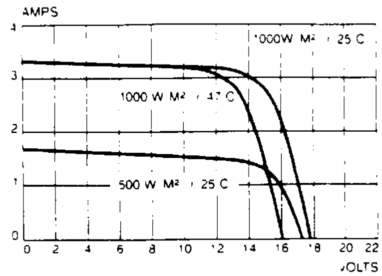
Rated Power	**43 Watts**
Current (typical at load)	2.95 Amps
Voltage (typical at load)	14.6 Volts
Short Circuit Current (typical)	3.3 Amps
Open Circuit Voltage (typical)	18.0 Volts

Power specifications are at standard test **conditions of 1000 W/M²** solar irradiance, 25°C **cell temperature** and solar spectral irradiance **per ASTM E892**

Weight	10.5 lb/4.8 kg



CHARACTERISTICS



The IV curve (current vs voltage) above demonstrates typical power response to various light levels at 25°C and a 47°C cell temperature.

- Minimum power upon final factory inspection is within 10% of rated power
- Module leakage current of less than 50µA at 3000 VDC
- Normal operating cell temperature (NOCT) as defined by ASTM E 1036 is 42°C + −2°C
- Laboratory tested for wide range of operating conditions (−40°C to 90°C 0 to 85% humidity)
- Passes Salt Fog Test per Mil-Standard 810
- Passes complete environmental requirements of JPL Specification No. 5101-61 (Block V)
- External grounding screw for electrical safety
- Ground continuity of less than 1 ohm for all metallic surfaces
- Ten-year limited warranty on power output *
- UL Listed (Per UL 1703)

Siemens Solar Industries
PO Box 6032 Camarillo CA 93011
Telephone (805) 482-6800 FAX (805) 388-6395

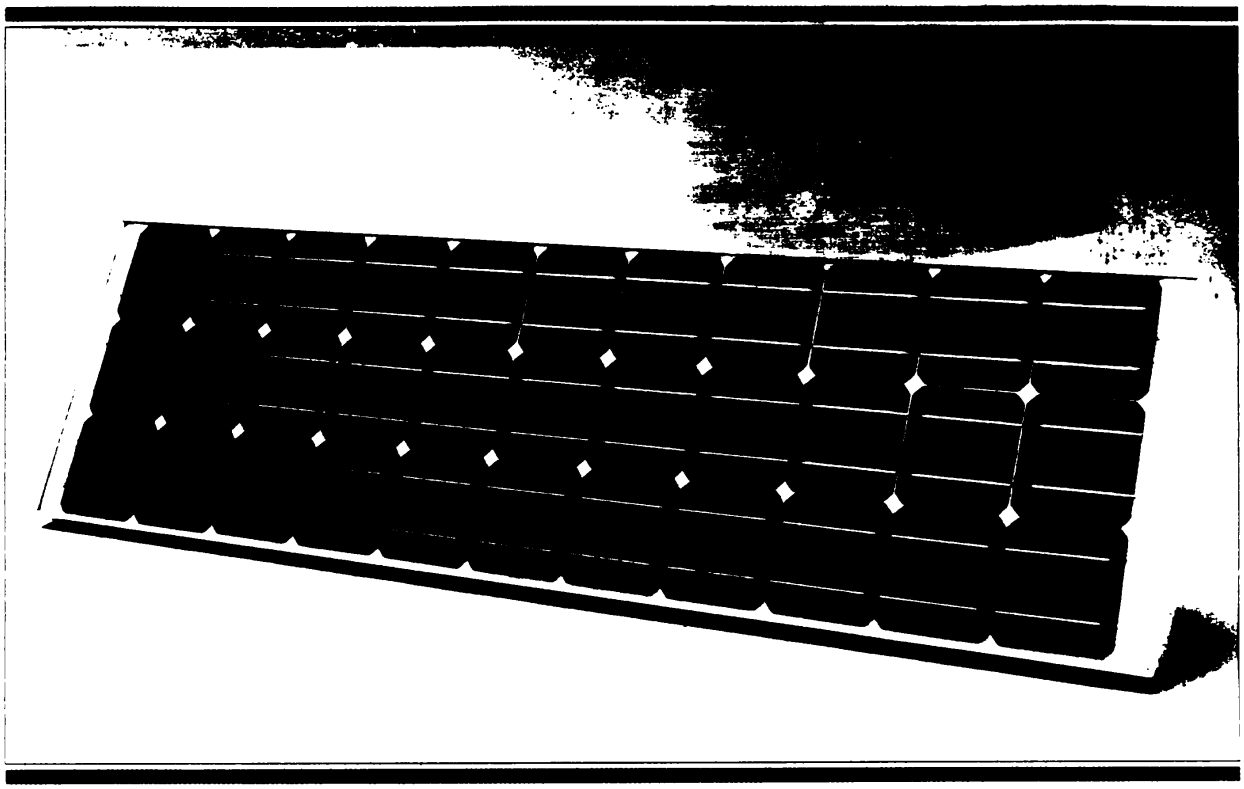
Charts are for estimating purposes only. Specifications subject to change without notice.

*Complete warranty and installation information is included in the module package or is available from Siemens or your Siemens Solar dealer prior to purchase.

SIEMENS
M75 High efficiency solar electric module
(used to charge emergency Nicad batteries at solar power lighthouses)

M75 High efficiency solar electric module

(Used to charge emergency Nicad batteries at solar power lighthouses)



RATED POWER 48 WATTS. The Siemens M75 is a 48 watt solar electric module with 33 high efficiency single crystal solar cells in series. It represents the optimum module configuration for battery charging in all but the very hotttest of climates.
Maintaining the quality, features and construction that are industry standards, the M75 solar module can withstand some of the world's harshest environments and continue to perform efficiently. It is an effficient, reliable and durable power module, suitable for a wide variety of applications.
Siemens solar electric modules are tested to meet or exceed industry standards, and even more rigorous Siemens quality and performance requirements.
10 YEAR WARRANTY. Designed for easy installation, the Siemens M75 solar module is sold with comprehensive installation and operating instructions. It carries a 10-year limited warranty on power output and is listed by Underwriters Laboratories (UL), an independent, not for profit organization, testing for public safety.

Siemens solar electric module features:

- **Silent operation**
- **Sunlight as fuel**
- **High power density**
- **Easy installation**
- **Rugged, durable construction**
- **Simple, reliable operation**
- **East to expand systems**
- **Low maintenance**
- **No moving parts to wear out**
- **No environmental pollutants**

M75 High efficiency solar electric module

FEATURES

Large, high efficiency, single crystal solar cells provide the highest light to energy conversion efficiency available from Siemens.

Cells are textured and have an anti-reflection coating.

Multiple redundant contacts provide a high degree of fault tolerance and circuit reliability.

Cells within a module are electrically-matched for increased efficiency.

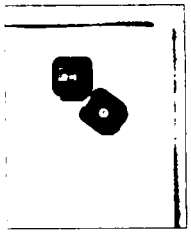
Circuit is laminated between layers of ethylene vinyl acetate (EVA) for moisture resistance, UV stability and electrical isolation.

Low iron tempered glass front for strength and superior light transmission.

Rugged anodized aluminum frame is designed for exceptional strength.

Side rails with multiple mounting holes for easy installation.

Tough, multi-layered polymer backsheet is used for environmental protection, resistance to abrasion, tears and punctures.



Two junction covers with lids are designed for easy field wiring, safety and environmental protection.

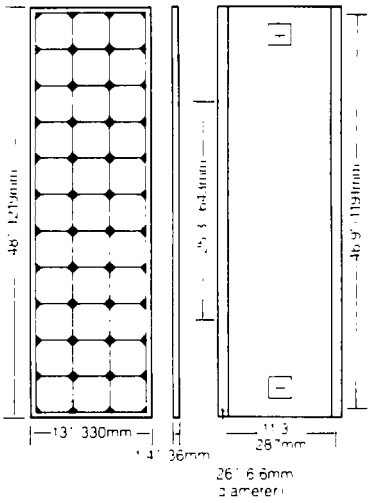
Wired-in bypass diodes reduce potential loss of power from partial array shading.

SPECIFICATIONS

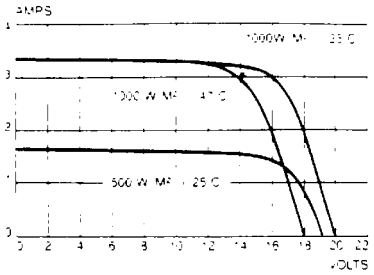
Rated Power	48 Watts
Current (typical at load)	3.02 Amps
Voltage (typical at load)	15.9 Volts
Short Circuit Current (typical)	3.4 Amps
Open Circuit Voltage (typical)	19.8 Volts

Power specifications are at standard test conditions of 1000 W/M² solar irradiance, 25°C cell temperature and solar spectral irradiance per ASTM E892.

Weight	11.6 lb 5.2 kg



CHARACTERISTICS



The IV curve (current vs. voltage) above demonstrates typical power response to various light levels at 25°C and at 47°C cell temperature.

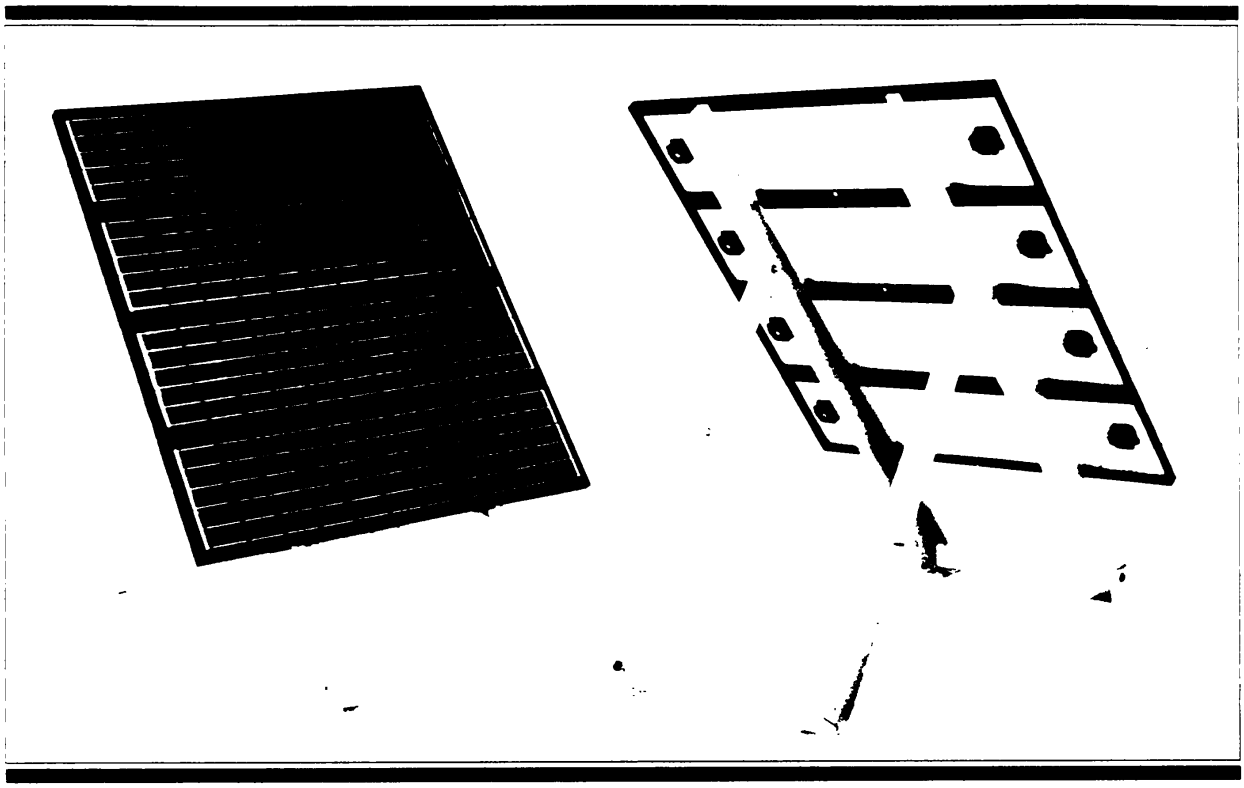
- Minimum power upon final factory inspection is within 10% of rated power
- Module leakage current of less than 50µA at 3000 VDC
- Normal operating cell temperature (NOCT) as defined by ASTM E 1036 is 42°C ± 2°C
- Laboratory tested for wide range of operating conditions (−40°C to 90°C, 0 to 85% humidity)
- Passes Salt Fog Test per Mil-Standard 810
- Passes complete environmental requirements of JPL Specification No. 5101-61 (Block V).
- External grounding screw for electrical safety
- Ground continuity of less than 1 ohm for all metallic surfaces
- Ten-year limited warrant, on power output *
- UL Listed (Per UL 1703)

Drams are for estimating purposes only. Specifications subject to change without notice.

*Complete warranty terms will be provided at time of purchase. Copies may be obtained from Siemens or your Siemens Solar dealer prior to purchase.

Siemens Solar Industries
P.O. Box 6032, Camarillo, CA 93011
Telephone: (805) 482-6600 FAX: (805) 388-6395

SGM Standard Ground Mount



Siemens Standard Ground Mounts are available in two sizes: Model SGM-4 for 2 to 4 module systems and Model SGM-8 fot up to 8 module systems.

Easy to install. Both models consist of two parallel channels with adjustable support legs and feet. (Packaged with detailed installation instructions and all necessary mounting hardware.

Rugged. Engineered for exceptional structural strength. Siemens Standard Ground Mounts are built to withstand wind speeds of up to 125 miles per hour.

Lightweight. Channels and support legs are fabricated from extruded Type 6061-T6 aluminum alloy; mounting feet are made of galvanized steel.

Environmentally Sound. Built to withstand environmental forces including wind, rain, snow, ice, blowing sand and solar radiation.

Corrosion resistant. Channels and support legs are anodized in accordance with architectural specification MIL A 8625 Type 2 Class 1 with nickel acetate seal.

Durable. Materials have been chosen for their durability and compatability with other materials in the array.

Flexible. Designed for optimum flexibilty in tilt angles (angle from the horizontal plane to the back of the modules). Siemens Standard Ground Mounts are adjustable in nominal 5 increments from 15 to 65.

SGM Standard Ground Mount

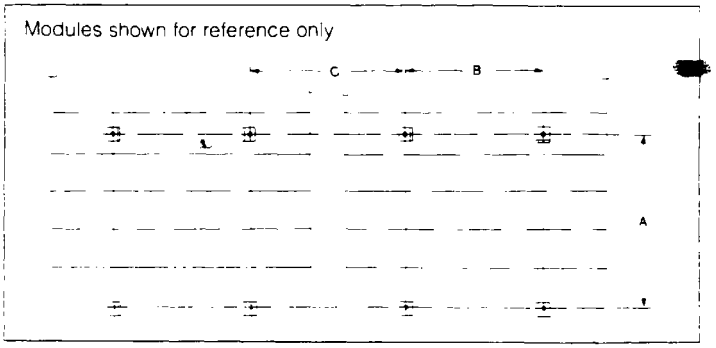
TYPICAL ASSEMBLY

Intended for installation on prepared footings at ground level, Siemens Standard Ground Mounts are sold with detailed installation instructions and include all structure components and necessary hardware to mount the structure to the foundation. (The foundation and associated hardware are the responsibility of the user.)

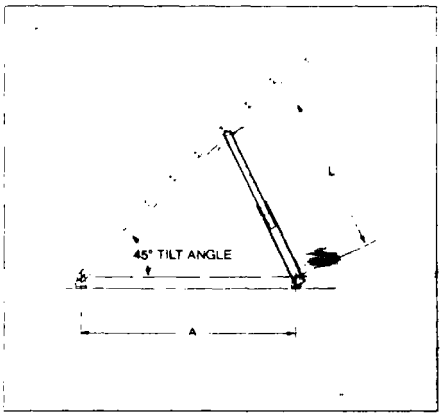
The Siemens worldwide distribution network can provide additional technical information in installing a photovoltaic system.

PLAN VIEW – FOOTPRINT DETAIL

Modules shown for reference only



TILT ANGLE



Side view of structure shown at 45° tilt

TILT ANGLE TABULATION

NOM TILT ANGLE	FOUNDATION LOCATION L		A		B**	C**		
	8 Module	4 Module	8 Module	4 Module		M55	M65	M75
15°	28"	28"	96"	68"	29"	24"	15 1/8"	21"
20°	28"	28"	80"	66"	↑	↑	↑	↑
25°	34"	31"	↑	↑	↑	↑	↑	↑
30°	40"	37"	↑	↑	↑	↑	↑	↑
35°	49"	40"	↑	↑	↑	↑	↑	↑
40°	54"	43"	↑	↑	↑	↑	↑	↑
45°	60"	46"	↑	↑	↑	↑	↑	↑
50°	69"	49"	↑	↓	↑	↑	↑	↑
55°	75"	54"	↓	66"	↑	↑	↑	↑
60°	80"	54"	80"	60"	↓	↓	↓	↓
65°	80"	54"	68"	55"	23"	24"	15½"	21"

**Common to both 4 & 8 module structures

PACKING DIMENSIONS

	4-Module Mount	8-Module Mount
Length	71⅝" / 181.9 cm	123⅞" 314.6 cm
Width	51⅜" / 13.3 cm	51⅜" / 13.3 cm
Depth	4½" 11.4 cm	4½" / 11.4 cm
Weight	33 lbs / 15.0 kg	45 lb / 20.4 kg

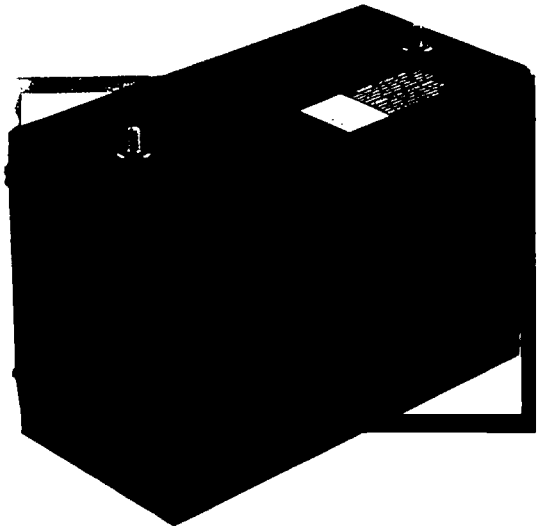
Siemens Solar Industries
P.O. Box 6032 Camarillo, CA 93011
Telephone (805) 482-6800 FAX (805) 388-6395

Charts are for estimating purposes only. Specifications are subject to change without notice. Complete installation information is included in the package or is available from Siemens or your Siemens Solar dealer prior to purchase.

AGV-Photovoltaic-Battery

Delco Remy

Delco 2000 Maintenance-Free Battery



AGV — SIZING AND RECOMMENDATIONS

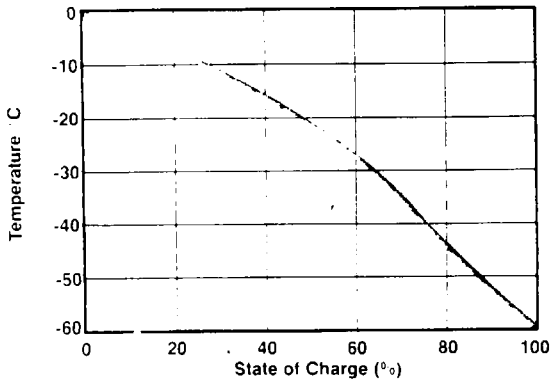
Battery applications are determined by the load applied to the battery. Once the load is established, the rated Ampere Hour capacity is determined by: (1) Estimating the Current Draw per battery and (2) Reading the Ampere Hour capacity from the Battery Capacity curve. Example: A battery with a current draw of 25 Amps operating @ 25 degrees Celsius has approximately a 75 rated Ampere Hour capacity.

- Opportunity Charging AGV systems are recommended with a Depth of Discharge not to exceed 15% of the battery rated Ampere Hour capacity for maximum battery life.
- Multiple batteries can be used in parallel to obtain proper operating conditions.
- Charging voltage is 15 to 16 volts with a charging current up to 75 Amps in opportunity charging systems.

SPECIFICATIONS:

Output Rating: 12 Volts Nominal
Capacity: 105 Ampere Hours (100 Hour Rating @ 25 Degrees Celsius)
Self-Discharge Rate: 4 Ampere Hours Per Month @ 27 Degrees Celsius
Dimensions: Length 13.0 inches (330.2mm)
Width 6.8 inches (172.0mm)
Height 9.5 inches (240.3mm)
Weight 60.2 pounds (27.3kg)

Electrolyte Freezing Point



PHOTOVOLTAIC — SIZING AND RECOMMENDATIONS:

As with AGV applications, once the load on the battery is established, the rated Ampere Hour capacity is determined by estimating the current draw per battery, and then reading the Ampere Hour capacity from the Battery Capacity curve.

- Daily discharge depths should not exceed 15% of the battery's rated Ampere Hour capacity for maximum battery life.
- The battery should maintain a *minimum of* 50% state of charge during worst operating conditions due to weather.
- Multiple batteries may be used in parallel to obtain proper operating conditions.
- Best operation is achieved between the temperatures of -5 and 35 degrees Celsius.
- Excellent electrolyte freezing protection is assured even for low states of charge. Example: A battery only 25% charged will not freeze until approximately -10 degrees Celsius.
- Charging voltage is 15.5 volts @ 27 degrees Celsius. For every degree Celsius increase (decrease), lower (raise) setting by 33 millivolts.

GNB

SECTION 62.26
SUNlyte™
PHOTOVOLTAIC RESERVE BATTERY

12-5000X

6 Cell, 12 Volt Valve Regulated Lead Acid Battery

100 AH at 100 Hour Rate

INNOVATIVE FEATURES

Sealed
- Never requires watering
- Spillproof and leak proof
- Explosion resistant
- Horizontal or vertical operation
- No gases escape under normal charging
- Operates at low internal pressure
- Increased operating safety

Immobilized Electrolyte
- Extended partial state of charge operation (at reduced capacities)
- Freezing tolerant
- Minimized need for equalization

Proprietary MFX Alloy
- Deep cycle capability
- Long life
- Low self-discharge rate

SPECIFICATIONS

Container and Cover - Reinforced polypropylene
Separators - Spun glass, microporous matrix
Safety Vent - 4 PSI nominal, self resealing
Self-Discharge - 0.5-1.0% per week
Terminals - Heavy duty copper

Charge Voltage - 2.25-2.35 VPC @ 25°C (77°F)
(15 amp max. current)
Positive Plate — Patented MFX alloy
Negative Plate — Lead tin
Estimated Cycle Life —
{8 hour rate to 1.75 VPC @ 25°C (77°F)}
300 cycles @ 80% DOD
600 cycles @ 50% DOD
1,000 cycles @ 20% DOD

PHYSICAL CHARACTERISTICS

	Overall Dimensions						Weight	
	Length		Width		Height		Net Each	
Type	In	mm	In	mm	In	mm	Lbs	Kgs
12-5000X	12.07	307	6.87	175	8.69	221	59	27

ELECTRICAL PERFORMANCE

Type	Cells Per Unit	Nom VDC Per Unit	AH Capacity to 1.75 VPC Avg. @ 25°C (77°F)					
			1 Hr	5 Hr	8 Hr	24 Hr	48 Hr	100 Hr
12-5000X	6	12	54	72	85	93	96	100

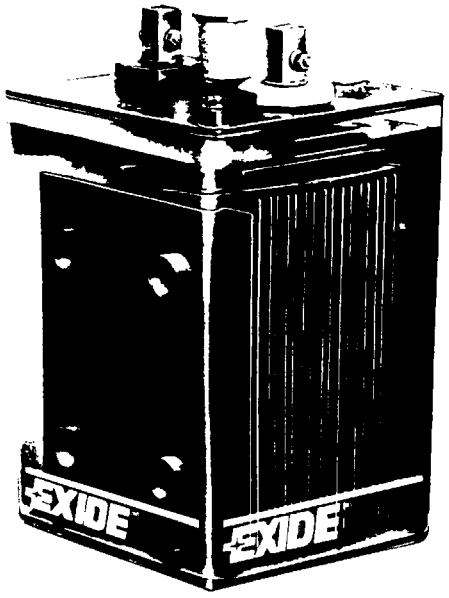
Section 92 00

EXIDE®

Tubular Stationary Batteries for Shallow Cycle Solar

Features

- ☐ TUBULAR POSITIVE PLATES—
  - ☐ For Outstanding Cycling Capability
  - ☐ Up to 3500 20% Discharges Available
  - ☐ Active Materials Locked Inside Tubes
- ☐ CALCIUM NEGATIVE PLATES—
  - ☐ Minimum Self Discharge
  - ☐ Reduced Water Loss
  - ☐ Lower Maintenance
- ☐ TRANSPARENT JARS—
  - ☐ For Ease Of Maintenance
  - ☐ Checking Electrolyte Level
  - ☐ Checking Sediment Condition
  - ☐ Observing Plate/Separator Condition
- ☐ SIZES 390 A.H.—2915 A.H.
  ELIMINATES PARALLELING STRINGS
- ☐ LONG LIFE—UP TO 22 YEARS WITH
  1% DAILY DEPTH OF DISCHARGE
- ☐ FLAME ARRESTORS STANDARD
- ☐ DOUBLE BURN PLATE LUGS
- ☐ MACHINED POST COMPRESSION
  POST SEALS



Applications (3 Days to 21 Days)

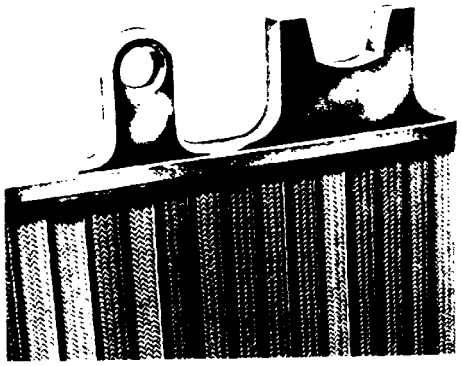
- ☐ SHALLOW CYCLE PHOTOVOLTAIC
  - ☐ Microwave
  - ☐ Rail Signal
  - ☐ Cathodic Protection
  - ☐ Communications
- ☐ SHALLOW CYCLE WIND
  - ☐ Microwave
  - ☐ Communications
- ☐ AVAILABLE
  - ● Charged and Wet
  - ● Dry Charged

SPECIFICATIONS

Cell Dimensions — Weights:

TYPE*	NOM. A.H. CAP.	CAT. NO.	OVERALL DIMENSIONS						WEIGHTS—VOLUMES							
			LENGTH		WIDTH		HEIGHT		UNPACKED		DOMESTIC PACKED		ELECTROLYTE ONLY 1.300 SP. GR.			
			in.	mm.	in.	mm.	in.	mm.	lbs.	kg.	lbs.	kg.	lbs.	kg.	gal.	l
EI-5	390	89944	4.87	124					62	28	65	30	25	12	2.3	8.6
EI-7	585	89608	6.37	162					82	37	87	40	30	14	2.8	10.5
EI-9	780	89945							93	42	100	46	28	13	2.6	9.7
EI-11	975	89946	7.87	200	10.8	274	18.2	462	114	52	123	56	36	17	3.3	12.3
EI-13	1170	89077							124	56	133	60	34	16	3.1	11.6
EI-15	1365	89947	9.87	251					153	70	159	72	44	20	4.0	15.3
EI-17	1560	89060							165	75	171	77	43	19	3.9	14.6
FHGS-17	1905	89473	9.0	229					226	103	227	104	65	30	6.0	22.7
FHGS-21	2310	89435	10.7	272	14.5	368	22.7	577	274	125	286	130	77	35	7.2	27.3
FHGS-25	2915	89948	13.2	335					331	150	341	156	99	45	9.2	34.8

*Suffix Number Indicates Total Plates Per Cell



**SPECIAL LEAD-OXIDE BLEND PACKS MAXIMUM POWER PER OUNCE OF ACTIVE MATERIAL.
THIS MEANS GREATER CYCLING CAPACITY IN LESS SPACE.**

Electrolyte has free access to the active material through thousands of tiny openings.

TUBULAR POSITIVE PLATE CONSTRUCTION

PLATE DIMENSIONS—

		HEIGHT	WIDTH	THICKNESS
POSITIVE:	EI	10.9 in 277 mm	9.2 in 234 mm	0.35 in 8.9 mm
	FHGS	14.4 in 366 mm	12.1 in 307 mm	0.35 in 8.9 mm
NEGATIVE	EI	11.4 in 290 mm	9.4 in 239 mm	0.24 in 6.1 mm
	FHGS	14.4 in 366 mm	12.1 in 307 mm	0.19 in 4.8 mm

SEDIMENT SPACE: 1.0 in. 25.4 mm

ELECTROLYTE OVER PLATES: FHGS—2.8 in. 71 mm
EI—2.1 in. 53 mm

CONTAINER: Styrene Acrylonitrile Copolymer

COVER: Styrene Butadiene

SEPARATORS: Microporous rubber

POST TYPE: EI— Single. FHGS—Double

POST SEAL TYPE: EI—Machined Post Radial Compression (Post Lock™).
FHGS—Machined Post Axial Compression

PLATE SUSPENSION TYPE:
Positive: EI—Bridge Hung. FHGS—Ledge Hung
Negative: EI—Bottom Supported. FHGS—Ledge Hung

VENT TYPE: Flame arrestor, fused alumina

SPECIFIC GRAVITY: 1.300

BOLT CONNECTORS: Stainless steel, standard English measure hex-head

INTERCELL CONNECTORS: Lead-plated copper

EXIDE®

Ironclad-Tubular

Type EJ
General Purpose

- ☐ Tubular positive-plate construction—available only from Exide.
- ☐ Tubular construction packs active material around the plate-grid spines, greatly reducing shedding and corrosion.
- ☐ Tubular construction guarantees the greatest discharge capacity per unit weight and unit volume.
- ☐ Thrives on cycling and floating service.
- ☐ Tolerates high ambient temperatures on a limited basis.
- ☐ 22 year life expectancy.
- ☐ This cell type incorporates a carefully engineered combination of plate surface area, plate thickness, and volume of electrolyte which optimizes performance for discharges from 1 minute to 8 hours in duration. It adapts well to those more demanding, complex load profiles with exceptionally high initial and ending current requirements, separated by a long period of more moderate constant-current demand.

SPECIFICATIONS

PLATE DIMENSIONS—

	HEIGHT	WIDTH	THICKNESS
POSITIVE	10.9 in 277 mm	9.2 in 234 mm	0.35 in 8.9 mm
NEGATIVE	11.4 in 290 mm	9.4 in 239 mm	0.24 in 6.1 mm

SEDIMENT SPACE: 0.75 in 19.1 mm
ELECTROLYTE OVER PLATES: 2.1 in 53.3 mm
CONTAINER: Styrene Acrylonitrile Copolymer
COVER: Styrene Butadiene
SEPARATORS: Microporous rubber
POST TYPE: EJ-5 thru 13—single post with copper insert
EJ-15 thru 21—double posts with copper inserts
POST SEAL TYPE: Post-Lock Seal™
PLATE SUSPENSION TYPE—
POSITIVE Bridge hung
NEGATIVE Bottom supported
VENT TYPE: Flame arrestor fused alumina
FLOAT VOLTAGE—
ACCEPTABLE RANGE 2.15—2.22 VPC
RECOMMENDED 2.20 VPC
SPECIFIC GRAVITY: 1.215 (1.170 tropical) available on request
BOLT CONNECTORS: Stainless steel standard English measure hex-head
INTERCELL CONNECTORS: Lead-plated copper

Capacities -Dimensions-Weights

TYPE	NOM A.H. CAP	LENGTH in	WIDTH in	HEIGHT in	WEIGHT lbs	ELECTRO VOLUME gal
EJ-7	360	4.87			70	1.9
EJ-9	480				81	1.7
EJ-11	600	6.37			101	2.4
EJ-13	720				111	2.0
EJ-15	840	7.87	10.8	18.2	136	2.9
EJ-17	960				147	2.7
EJ-19	1080	9.87			173	3.9
EJ-21	1200				182	3.6
FHGS-15	1365	7.5	14.5	22.7	191	4.5

ABSOLYTE IIP Batteries

THE WORLD LEADER IN SEALED BATTERY POWER

Proven field experience since 1983. The Absolyte IIP represents the third generation of the Absolyte product line. Without an increase in size, it offers 15% more capacity than its predecessor, the Absolyte II.

Patented MFX positive grid alloy* provides long-life. This propriety alloy gives Absolyte IIP superior cycling performance and excellent float characteristics: 1200 cycles to 80% D.O.D. and a twenty year life in float service @ 25C (77 F). This alloy also has low gassing characteristics and is designed to allow for deep discharge recovery.

Absorbed glass mat seperators for efficient operation. The positive and negative plates are seperated by a highly porous fiberglas mat which functions as the electrolyte retainer and provides the highest oxygen recombination efficiency. In addition, the low resistance of the glass mat improves high rate discharge performance.

Reduced installation and maintenance time. The Absolyte IIP cells are housed in protective, modular steel trays designed for easy installation and balanced thermal management. Modules may be stacked horizontally (preferred) or installed vertically (50A, 90A only). When stacked horizontally, the standard Absolyte IIP is qualified for use in U.B.C. Seismic Zone IV installations. With the sealed design, maintenance is also kept to a minimum. No water additions or scheduled equalization charges are required. Periodic visual inspections, voltage readings and connection retorqing is all that is required.

Highest reliability is assured by GNB's quality program. Cell covers are hermetically sealed using a special GNB double-sealing process. Post seals are formed by fusing the lead bushing to the post with a robotic welder. Cells are checked by an automated, ultra-sensitive helium leak detection unit prior to the controlled electrolyte "fill by weight" process. These steps virtually eliminate any potential for leaking cells. Finally, all cells are capacity tested prior to shipment to verify attainment of specified ratings.

APPLICATIONS

The Absolyte IIP batteries are ideal for numerous applications including:

Telecommunications
Uninterruptible Power Systems
Switchgear and Control

Railroad Signal and Communication
Photovoltaics
Marine
Alternative Energy Systems

ADDED FEATURES & BENEFITS

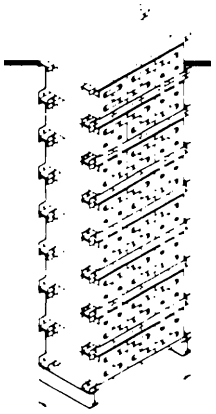
Does not require a seperate Battery room
Transparent, flame retardant module cover
Recombination efficiency greater than 99%
Freezing tolerant
Deep discharge recovery
Accepts high rate charge
Meets U.B.C. Seismic Zone IV requirements
Simple cell replacement capability

CELL SPECIFICATIONS

Container and Cover - Polyproylene is standard. Flame retardant, UL94 V-0/28% L.O.I. is optional.
Separators - Spun glass, microporous matrix.
Safety Vent - 400mb (6psi) nominal, self-resealing (patented).
Teriminals - Integral solid copper core.
Positive Plate - Patented MFX grid alloy.*
Negative Plate - Lead calcium grid alloy.
Life - 20 years float @ 25 C (77F).
Self Discharge - 0.5 to 1% per week maximum @ 25 C (77F).
Float Voltage - 2.23 to 2.27 VPC (2.25 recommended) @ 25 C (77F).

ASSEMBLY CONFIGURATIONS

Horizontal Stack Assembly (Preferred). Depth is overall, including module cover assembly. Add 102mm (4") for bottom I-beam supports to determine total height (width) of assembled horizontal stack.



Vertical Assembly, Side-by-side. Height is overall, including module cover assembly. Add 51mm (2") for bottom channel support to determine final height.

ABSOLYTE IIP
Batteries

Absolyte IIP Module Weights and Dimensions

MODULE TYPE	VOLTS	NOM AH CAP 100 HR	STACKING DIMENSIONS						UNPACKED WEIGHT		DOMESTIC PACKED WEIGHT		EXPORT PACKED WEIGHT	
			LENGTH		WIDTH		DEPTH OR HEIGHT*							
			IN	MM	IN	MM	IN	MM	LBS	KGS	LBS	KGS	LBS	KGS
50A														
6-50A05	12	130	17.19	437	8.53	217	16.22	412	157	71	176	80	228	104
6-50A07	12	200	21.69	551	8.53	217	16.22	412	209	95	228	104	280	127
6-50A09	12	270	26.19	665	8.53	217	16.22	412	252	114	271	123	323	147
6-50A11	12	340	30.69	780	8.53	217	16.22	412	313	142	332	151	384	174
6-50A13	12	410	35.19	894	8.53	217	16.22	412	356	162	381	173	433	197
6-50A15	12	480	39.69	1008	8.59	218	16.22	412	417	189	442	201	494	224
90A														
6-90A05	12	230	17.19	437	8.53	217	23.56	599	235	107	254	115	322	146
6-90A07	12	340	21.69	551	8.53	217	23.56	599	316	143	335	152	413	187
6-90A09	12	460	26.19	665	8.53	217	23.56	599	396	180	415	188	493	224
6-90A11	12	570	30.69	780	8.53	217	23.56	599	477	216	502	228	581	264
6-90A13	12	690	35.19	894	8.53	217	23.56	599	557	253	582	264	661	300
6-90A15	12	800	39.69	1008	8.59	218	23.56	599	637	289	668	303	747	339
3-90A17	6	920	24.50	622	8.59	218	23.56	599	376	171	395	179	474	215
3-90A19	6	1000	26.75	679	8.59	218	23.56	599	416	189	435	197	514	233
3-90A21	6	1100	29.00	737	8.59	218	23.56	599	456	207	478	217	557	253
3-90A23	6	1200	31.25	794	8.59	218	23.56	599	497	226	522	237	601	273
3-90A25	6	1300	33.50	851	8.59	218	23.56	599	538	244	564	256	642	291
3-90A27	6	1500	35.75	908	8.59	218	23.56	599	578	262	606	275	685	311
100A														
3-100A13	6	740	19.93	506	8.53	217	26.38	670	328	149	356	162	436	198
3-100A15	6	870	22.18	563	8.59	218	26.38	670	374	170	408	185	489	222
3-100A17	6	990	24.50	622	8.59	218	26.38	670	424	192	446	202	528	240
3-100A19	6	1100	26.75	679	8.59	218	26.38	670	470	213	491	223	574	260
3-100A21	6	1200	29.00	737	8.59	218	26.38	670	515	234	539	245	623	283
3-100A23	6	1300	31.25	794	8.59	218	26.38	670	561	255	589	267	674	306
3-100A25	6	1400	33.50	851	8.59	218	26.38	670	608	276	637	289	723	328
3-100A27	6	1600	35.75	908	8.59	218	26.38	670	653	296	684	310	772	350
3-100A29	6	1700	38.00	965	8.59	218	26.38	670	704	319	736	334	824	374
3-100A31	6	1800	40.25	1022	8.59	218	26.38	670	750	340	783	355	873	396
3-100A33	6	1900	42.50	1080	8.59	218	26.38	670	795	361	829	376	920	417
1-100A39	2	2200	19.93	506	8.53	217	26.38	670	328	149	356	162	436	198
1-100A45	2	2600	22.18	563	8.59	218	26.38	670	374	170	408	185	489	222
1-100A51	2	2900	24.50	622	8.59	218	26.38	670	424	192	446	202	528	240
1-100A57	2	3300	26.75	679	8.59	218	26.38	670	470	213	491	223	574	260
1-100A63	2	3600	29.00	737	8.59	218	26.38	670	515	234	539	245	623	283
1-100A69	2	3900	31.25	794	8.59	218	26.38	670	561	255	589	267	674	306
1-100A75	2	4200	33.50	851	8.59	218	26.38	670	608	276	637	289	723	328
1-100A81	2	4800	35.75	908	8.59	218	26.38	670	653	296	684	310	772	350
1-100A87	2	5100	38.00	965	8.59	218	26.38	670	704	319	736	334	824	374
1-100A93	2	5400	40.25	1022	8.59	218	26.38	670	750	340	783	355	873	396
1-100A99	2	5700	42.50	1080	8.59	218	26.38	670	795	361	829	376	920	417

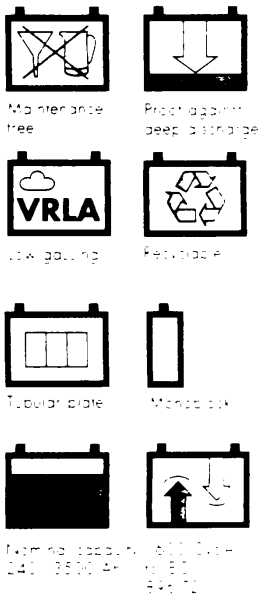
*Includes [illegible] for Module Cover Assembly

NOTE: Design and dimensions subject to change without notice. If questions arise, contact your local C&D sales representative for [illegible]

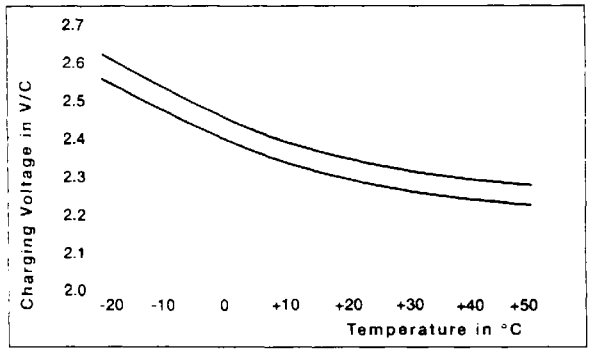
dryfit A 600 solar:

Completely maintenance-free sealed VRLA batteries (Valve Regulated Lead-Acid) in dryfit technology

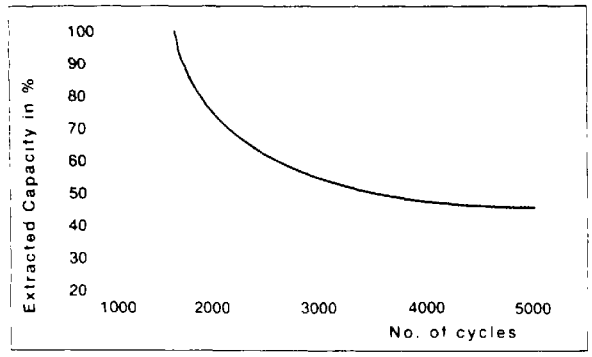
dryfit A 600 solar batteries are designed for medium to large power requirements. Typical applications include: Solar and wind-driven power plants power supply utilities, postal applications, solar stations, radio telecommunications railway operations.



Type No	Type	Nominal capacity (C_{120}) Ah	Discharge current (I 10) A	Length (l) max in mm	Width (b) max. in mm	Height (h_1) max in mm	Height (h_2) max in mm	Installed length (L) in mm	Pole pairs	Weight with electrolyte in kg
0 11 81165 00	4 OPzV 240	240	2.4	105	208	360	398	112	1	19.5
0 11 81166 00	5 OPzV 300	300	3.0	126	208	360	398	135	1	23.5
0 11 81167 00	6 OPzV 360	360	3.6	147	208	360	398	155	1	28.0
0 11 81168 00	5 OPzV 400	400	4.0	126	208	475	513	135	1	31.0
0 11 81169 00	6 OPzV 500	500	5.0	147	208	475	513	155	1	36.5
0 11 81170 00	7 OPzV 600	600	6.0	168	208	475	513	175	1	42.0
0 11 81171 00	6 OPzV 720	720	7.2	147	208	650	688	155	1	50.0
0 11 81172 00	8 OPzV 960	960	9.6	215	193	650	688	220	2	68.0
0 11 81173 00	10 OPzV 1200	1200	12.0	215	235	650	688	220	2	82.0
0 11 81174 00	12 OPzV 1400	1400	14.0	215	277	650	688	220	2	97.0
0 11 81175 00	12 OPzV 1700	1700	17.0	215	277	800	838	220	2	120.0
0 11 81161 00	16 OPzV 2300	2300	23.0	215	400	775	815	220	3	160.0
0 11 81162 00	20 OPzV 2900	2900	29.0	215	490	775	815	220	4	200.0
0 11 81163 00	24 OPzV 3500	3500	35.0	215	580	775	815	220	4	240.0



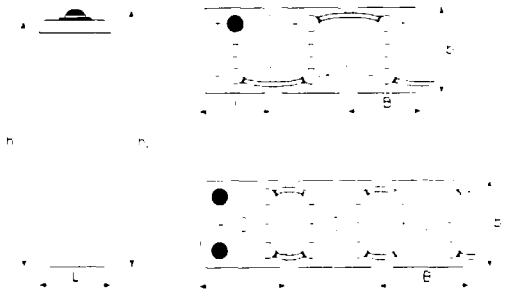
For continuous charging 2.28 - 2.32 V per cell is recommended at 20 °C. The charging voltage must be compensated according to the curve for continuously different battery ambient temperature.



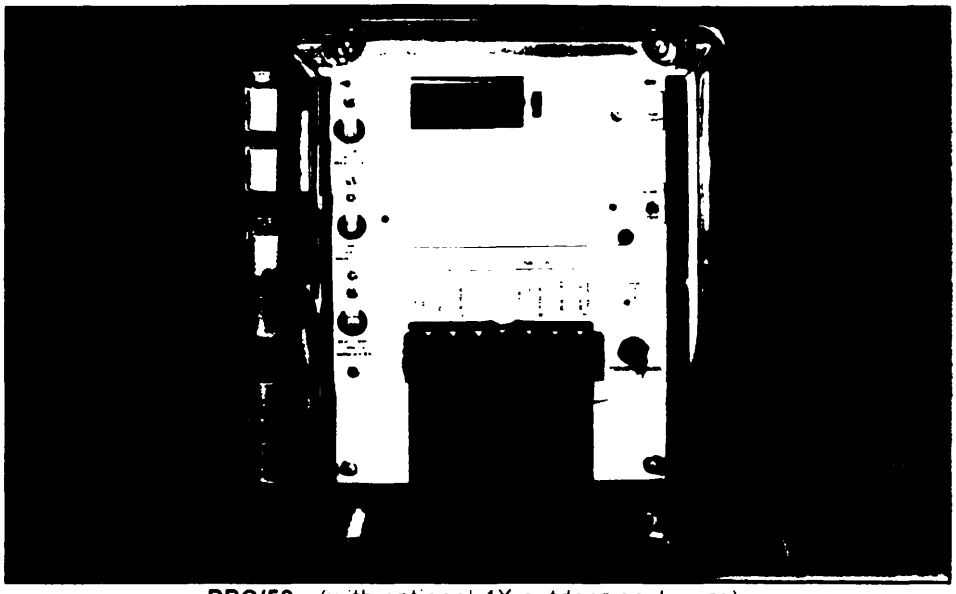
Endurance in cycles according to IEC 896-2

Capacity C_1 - C_{100}					
Types	C_1	C_3	C_5	C_{10}	C_{100}
	1.67 VPC	1.75 VPC	1.77 VPC	1.80 VPC	1.85 VPC
4 OPzV 240	108	151	175	200	240
5 OPzV 300	135	189	219	250	300
6 OPzV 360	162	227	263	300	360
5 OPzV 400	180	252	292	350	400
6 OPzV 500	225	315	365	420	500
7 OPzV 600	270	378	438	490	600
6 OPzV 720	324	454	526	600	720
8 OPzV 960	432	605	701	800	960
10 OPzV 1200	540	756	876	1000	1200
12 OPzV 1400	630	882	1022	1200	1400
12 OPzV 1700	765	1071	1241	1500	1700
16 OPzV 2300	1035	1449	1679	2000	2300
20 OPzV 2900	1305	1827	2117	2500	2900
24 OPzV 3500	1575	2205	2555	3000	3500

Dimensions and connections



PPC/50 - Photovoltaic Charge Control
SPECIALTY CONCEPTS,INC.
PHOTOVOLTAIC CHARGE CONTROLLER



PPC/50 - (with optional 4X outdoor enclosure)

The PHOTOVOLTAIC POWER CONTROL (PPC/50) is a versatile, industrial quality controller for the efficient use of the photovoltaic energy and the protection of expensive batteries. It is available for 12, 24, 36 and 48 volt negative ground systems. Models are available for 50 amps of charge current.

The PPC/50 consists of a series-relay battery charge regulator with low-voltage load dissconnect, battery, array and load circuit breakers, system status lights and digital metering. The lights indicate "CHARGING" and "LOW-VOLTAGE LOAD DISCONNECT" conditions and the digital meter monitors battery voltage, charging and load current. A provision is made for monitoring an external shunt. The PPC/50 is housed in a sealed indoor enclosure and has a terminal block for up to 6 guage wire.

FEATURES

CHARGE REGULATION

50 amp charge current, 12, 24, 36 or 48 volt
Two-step, series charging, 12, 24 v
Single step, series charging, 36, 48 v
Adjustable charging set-points
Plug-in temperature compensation

LOW-VOLTAGE LOAD DISCONNECT (LVD)

30 amp LVD, 12 volt
20 amp LVD, 24 volt
15 amp LVD, 36 and 48 volt
Adjustable charging set-points
Plug-in temperature compensation

DESIGN FEATURES

Maximum array usage
Over-current protection and manual disconnects - battery, array and load circuit breakers
Reverse polarity protection
Reverse leakage protection
Lightning protection
Input noise suppression
Remote battery voltage sense

MONITORING

Digital volt/amp meter

External shunt metering
Charging Light
Load disconnect light

MOUNTING

Indoor wall mount enclosure
Outdoor enclosure (optional)

OPERATION (12,24 volt units)

Note: The operation of the 36 or 48 volt unit is identical with the exception that no float unit is included.

CHARGE REGULATION -

The PPC/50 features two charging steps to effectively charge the batteries and protect them from over-charge damage. The PPC/50 monitors the battery and array voltage, using a relay to control the charging.

STEP 1 - FULL CHARGE: At sunrise, the rising array voltage will energize the charging relay and initiate a full charge mode, as indicated by the "CHARGE MODE" light. All available current from the array will pass through to the batteries and raise the battery voltage until the battery reaches the full charge termination threshold.

STEP 2-FLOAT CHARGE: When the battery reaches the full charge termination threshold, the full-charge mode ends and the "CHARGE MODE" light goes out. The PPC/50 resumes charging at a reduced charging rate. As the battery approaches the float voltage, the current will taper off, eventually reaching the battery's maintenance current.

LOW-VOLTAGE DISCONNECT-

The low-voltage disconnect (LVD) of the PPC/50 prevents damage from deep-discharge of the batteries by automatically disconnecting the loads. The disconnect threshold is load current compensated, and has a time delay to prevent false disconnects. When disconnect occurs, the load relay is energized and opens, and the "LOAD DISCONNECT" light will indicate that the loads have been disconnected. Normal battery charging will continue. At the reconnect threshold the loads will automatically be reconnected and the light will go off. The LVD function has a reset/disable switch and user adjustable set-points.

DESIGN FEATURES-

The PPC/50 has many superior design features that contribute to the controller's efficiency and reliability. This controller provides maximum utilization of the array during hours of charging by reconnecting the array for direct charging as soon as the battery drops below a full charge set-point. Over-current protection is provided in the form of circuit breakers. A timing circuit will disconnect the array at night, to prevent reverse current leakage. The control circuit is protected from reverse polarity connection on all inputs, and has MOV lightning protection. Input noise suppression filters out most of the spikes and interference to reduce false switching. Remote battery sense terminals allow accurate monitoring of battery voltage.

OPTIONAL ENCLOSURES

3R - Outdoor, moderate protection
4X - Outdoor, maximum protection

Photovoltaic Power Control

PARAMETERS	UNITS	NOMINAL VOLTAGES			
		12 v	24 v	36 v	48 v
Charge Current, Continuous	(Amps)	50	50	50	50
Charge Current, Max (60 seconds)	(Amps)	65	65	65	65
Load Current, Continuous (1)	(Amps)	30	20	15	15
Load Current, Max (60 seconds) (2)	(Amps)	39	26	20	20
Array Voltage, Max Voc	(Volts)	22	44	66	88
Operating Voltage @ Battery, Minimum	(Volts)	8.5	17.0	25.5	34.0
Quiescent Current (3)	(Milliamps)	20	20	20	20
Current Consumption, Charging (4)	(Milliamps)	170	170	110	110
Current Consumption, Load Disconnected (5)	(Milliamps)	150	110	100	100
Voltage Drop, Typ. (Array to Battery)	(Volts @ Max rating)	.15	.15	.15	.15
Voltage Drop, Typ. (Battery to Load)	(Volts @ Max rating)	.40	.40	.40	40
Full Charge Termination (6)	(Volts)	14.8 ± .2	29.6 ± .4	44.4 ± .6	59.2 ± .8
Full Charge Resumption	(Volts)	12.8 ± .2	25.6 ± .4	38.4 ± .6	51.2 ± .8
Load Disconnect (7)	(Volts)	11.5 ± .2	23.0 ± .4	34.5 ± .6	46.0 ± .8
Load Disconnect Adjustment Range	(Volts)	11.0 to 12.0	22.0 to 24.0	33.0 to 36.0	44.0 to 48.0
Load Reconnect	(Volts)	13.0 ± .3	26.0 ± .6	39.0 ± .9	52.0 ± 1.2
Float Voltage	(Volts)	14.1 ± .2	28.2 ± .4	NA	NA
Float Current, Max	(Amps)	3	1	NA	NA
Meter Accuracy, Voltage		1 %	1 %	1 %	1%
Meter Accuracy, Current		1 %	1 %	1 %	1 %
Temp. Compensation coef.(from 25°C)	(Volts/°C)	-.03	-.06	-.09	-.12
Operating Temp. Range	(°C)	0 to 50	0 to 50	0 to 50	0 to 50
Storage Temp. Range	(°C)	-20 to 70	-20 to 70	-20 to 70	-20 to 70

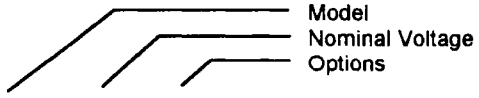
Notes:
(1) Non-inductive.
(2) Carry only, Non-switching
(3) Both relays unenergized, red L.E.D.s off, typical value.
(4) Charge relay energized, red L.E.D. on, typical value.
(5) LVD relay energized, red L.E.D. on, typical value.
(6) Set-point adjustable. Refer to table.
(7) Decreases by 10 mv for every amp of load current

FULL CHARGE TERMINATION SET-POINTS

Control Voltage	SWITCH POSITIONS A	B	C	D
12	15.3	14.8	14.3	13.8
24	30.6	29.6	28.6	27.6
36	45.9	44.4	42.9	41.4
48	61.2	59.2	57.2	55.2

PART NUMBERING KEY

EXAMPLE:



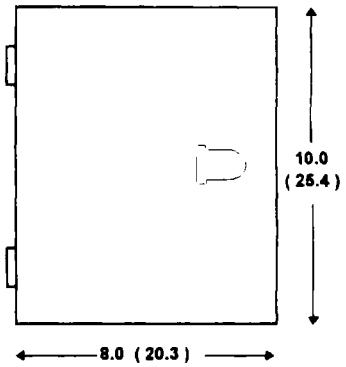
PPC/50 - 12 - 4X

MODEL	NOMINAL VOLTAGE	OPTIONS
PPC/50	12 24 36 48	3R - Outdoor enclosure - moderate protection 4X - Outdoor enclosure - maximum protection

DIMENSIONS

In Inches (cm)

STANDARD ENCLOSURE (NEMA 1)



Depth: 4.0 inch (10.2 cm)
Shipping weight: 10 lbs. (4.5 Kgs.)

Specifications and product availability subject to change without notice.

SPECIALTY CONCEPTS, INC.
8954 MASON AVE., CHATSWORTH, CA 91311 USA PH: (818) 998-5238, FAX: (818) 998-5253